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Convergence Towards an Optimal Currency Area in the European Union

Santiago Botto Tornielli
Yale University

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Santiago Botto Tornielli

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Adviser: Dr. Rakesh Mohan

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Abstract:

This essay uses the European Union as a case study to analyze the conditions for an optimal currency area, the regional differences that give rise to divergences from optimal conditions, and how to measure divergence. The essay reviews the extensive body of theoretical literature on optimal currency areas (OCA), analyzes the historical evidence and documents that outline the economic institutions of the EU, and performs an empirical factor analysis on different possible indicators of convergence to identify to the most important variables. In the absence of adjustment mechanisms, economic geography plays an essential role in forming an OCA because members of a currency area must have similar monetary policy needs. The most important indicators of convergence towards an optimal currency area include measures of real effective exchange rates, labor productivity, inflation, and patterns of production.

Table of contents

Introduction

Monetary unions such as the European Union raise interesting questions about the structural forces that affect economic performance. Most economic and monetary unions are associated with nation states that have integrated economies, and they are traditionally considered the basic units of macroeconomic thought. The United States, Japan, and individual European countries like the United Kingdom are monetary unions, with a single currency and monetary policy. The European Union instead developed from a voluntary union of individual member states, which chose to give up their monetary independence. Their policymakers designed a monetary union from the ground up, informed by economic thinking about the best practices for a monetary area. The plans to form a monetary union of European states provoked intense debates about whether the union was feasible or optimal for its members. The unique historical development of the European economic and monetary union and the scope of arguments about its creation present a fascinating case study in the structures of a currency area.

This essay will use the European Union as a case study to analyze the conditions for an optimal currency area, the regional differences that give rise to divergences from optimal conditions, and how to measure divergence. The essay will employ three sources of insight: the extensive body of theoretical literature on optimal currency areas (OCA), the historical evidence and documents that outline the economic institutions of the EU, and the extensive database of European statistics that can be analyzed empirically. Using these sources, the essay will answer the question: To what extent did the creation of the EU reflect the role of structural integration in an optimal currency union, and how can structural integration be measured?

The essay has three main parts: an overview of the literature on optimal currency area theory, a theoretical analysis of the EU's history, founding documents, and where they diverge

from an optimal currency area, and an empirical factor analysis of how these divergences from an optimal currency area might be measured.

The literature on optimal currency area theory developed largely from Robert Mundell's work in the 1960s. Other scholars then used empirical methods to analyze Mundell's conclusions and draw out more precise requirements for an optimal currency area. The review of OCA theory will identify the essential requirements for an optimal currency area. Then, the theoretical requirements for an optimal currency area will be compared with the history and economic institutions of the EU. There is extensive documentation about the debates throughout the 20th century that gave rise to the EU.

The second part of the essay compares evidence from these debates and from foundational documents such as the Delors Report and the Treaty of Maastricht against the requirements of an optimal currency area. The analysis reveals three significant gaps between the economic conditions and institutions of the EU and the requirements of an OCA.

The final part of the essay will consider how to measure these divergences from optimal currency area through empirical tools. Because the main challenge is the large number of different indicators that can be used to measure structural divergences between regions of an optimal currency area, a factor analysis will be conducted. Factor analysis can identify correlations between many different variables, and indicate the underlying factors that explain total variance across the variables. The analysis identifies three main factors that indicate structural divergence from an optimal currency area: price levels and labor productivity across regions, real and nominal effective exchange rates, and labor costs. These indicators could be used to study policy effects on the structure of a currency area. To illustrate one potential

application, the indicators will be used to evaluate the divergence between Poland and the Eurozone.

The essay will conclude with some key takeaways about the implications of the EU as a case study for integration into an optimal currency area. In the absence of adjustment mechanisms, economic geography plays an essential role because members of a currency area must have similar monetary policy needs.

1: Optimal currency area theories and conditions

There is a large body of evidence on what constitutes an optimal currency area. This literature originated in the 1960s and has continued to examine how the composition of a currency area affects its policies and wellbeing. An overview of theories about optimal currency areas will help to place the EU's historical policies in context, and to focus the analysis of where the EU diverges from an optimal currency area. This initial section of the essay will review the classic theory of optimal currency areas, then move through the more current literature about the role of asymmetric shocks in the functioning of a currency area, and draw implications for the case of the EU.

1.1: Overview of currency area theories

During the 1960s, Robert Mundell pioneered a theory of optimal currency areas arguing that an optimally functioning currency area has to include economic areas that all experience similar shocks and respond to them in a similar way.[1] More recent scholarship has examined different types of shocks, particularly asymmetric shocks that affect a specific geographical region or industry sector. A related line of literature studied the divergent effects of monetary shocks specifically. Finally, analyses focusing on the effect of economic shocks on US states found that if a monetary union includes disparate economic regions, it can still function optimally if there are other mechanisms for the regions to adjust. In the case of the United States, flexible labor markets and federal fiscal transfers allow for adjustment when there are specific shocks to parts of its economy.[2] In the case of the European Union, the lack of adjustment mechanisms means that the gaps between the design of the EU and OCA theory become

[1] Mundell (1961)
[2] HM Treasury, The United States as a monetary union: EMU study (2003)

especially important. Where member states have divergent monetary policy needs, the currency area will become suboptimal and requires strengthening through specific policies. This overview of OCA theory will help to identify particularly important requirements for an optimal currency area, which will later be evaluated against the design of the EU.

1.2: Mundell's optimal currency area theory

Robert Mundell's theory of optimal currency areas creates a framework to evaluate a currency area's effectiveness by the integration of its component economic areas. Mundell's work represents one of the earliest analyses of the effective functioning of a currency area. Mundell observed the shocks to the Bretton Woods monetary system during the 1960s and formulated a simple intellectual exercise about the functioning of a currency area. According to this framework, a currency area functions optimally if it covers an appropriate geographical area.[3] Specifically, the geographical area included in the currency area needs to contain economies that all experience the same economic shocks and react to them in the same way. Mundell explains this concept through the example of a multi-regional currency area.[4] In this hypothetical example, there are two regions with different patterns of production specializing in different goods, united under a single currency. One region suffers a negative economic shock resulting in higher unemployment. The optimal response for monetary policy in this region would be to pursue inflationary policies and a devaluation of the currency, in order to stimulate its economy. However, the negatively affected region depends on a national authority for its monetary policy. If the national monetary authority pursues inflationary policies across the whole country, then it will help the region which suffered the negative shock, but other regions

[3] Mundell (1961), 657
[4] Mundell (1961), 658

will experience higher inflation than is optimal for them.[5] Naturally, the individual regions have lost the ability to push for a local stimulus by using expansionary monetary policy or devaluations. For Mundell, uniting the whole world into a single currency area would not be optimal because it would be too large to function properly. Alternatively, very small regions are not optimal either because it becomes too difficult to exchange many different currencies constantly when conducting business across regions. Instead, an optimal currency area needs to include as many economic regions as possible, but those regions must all experience similar economic shocks.

The key insight in Mundell's paper is that for a currency area to be optimal, its members must have the same monetary policy needs. However, in many cases actual patterns of economic activity exist within nations or regions in ways that are not necessarily integrated or optimal for the conduction of monetary policy. An optimal currency area needs to have member parts with the same optimal monetary policy. If the members of a currency area are nation states, as in the case of the EU, then those states need to be similar enough that the same monetary policy can be applied to them with optimal results for output and price levels.[6] Mundell's theory also implies that the most important determinant of optimal monetary policy is whether it is well suited to the geographical area which it affects. In particular, there should not be any major structural discrepancies between the different economic regions or sectors that will be affected. If there are structural differences then one part of the currency area might have different labor costs, productivity, or price levels from another part. One region could experience the sort of deflationary shock that Mundell thought about, while another suffers an inflationary shock. In

[5] Mundell (1961), 658-659
[6] Mundell (1961)

this case a single monetary policy will likely not be optimal for the whole area. Many years later Mundell commented on the upcoming implementation of the European Monetary Union in 1999.[7] He remarked on the need for all the member countries to meet the convergence criteria set out by the EU. These convergence criteria were intended to ensure exactly the sort of integration that Mundell considered essential for an optimal currency union. Even though a number of countries did not meet the convergence criteria for essential indicators like the fiscal deficit, the plan for integration proceeded. Mundell was optimistic that the core and peripheric countries were fundamentally not too different.[8] However, the debate raised questions about how to measure the magnitude of structural differences between members of the EU. The question of measurement will be considered empirically later in this essay. Mundell seems to have backed the Maastricht criteria, which measured nominal indicators. Much of the literature after Mundell focused on measuring the types of shocks that affect members of a currency area.

1.3: Evidence from asymmetric shocks

Later studies built on Mundell's theory of optimal currency areas by studying how component regions of a currency area respond to shocks. Mundell's original thought experiment dealt with a hypothetical shock affecting one economic region but not another within the same currency union. Therefore, a properly integrated and optimal currency area should have component regions that do not experience asymmetric shocks that affect one region and not another. Additionally, if a shock affects the entire currency area, then its component regions should respond similarly to the shock in order for Mundell's optimal conditions to hold. These conditions reveal a more detailed view of the requirements for an optimal currency area. As the

[7] Mundell (1997), 215
[8] Mundell (1997), 216

literature on asymmetric shocks suggests, members of a currency area need to have a synchronized business cycle and similar economies with compatible patterns of production, in order to form an optimal currency area.

Barry Eichengreen and Tamim Bayoumi studied the effects of shocks on different European countries and compared them to shocks in U.S. states.[9] The two most important economic indicators of a shock are logically the output and price level of an economy. There have been a number of studies about the variation in output and price level between European countries compared to the United States. In general, these studies found that the European countries suffered more variable or asymmetric shocks to output and prices than did U.S. states.[10] However, Eichengreen and Bayoumi claimed that studying the behavior of output and prices may confuse the initial impact of a shock, and the subsequent response of the economy to the initial shock. Therefore, they use GDP data to attempt to identify long-term supply shocks and short-term demand shocks to European economies. The authors found that in general, European economies experience more variable demand and supply shocks than do U.S. regions, and take significantly longer to adjust to them.[11] Comparing the "core" European economies to the entire U.S., the variability of shocks seems to be similar, but there is a "core" of U.S. regions with even more synchronized economies. Eichengreen and Bayoumi suggested that the delay in adjustment could be accounted for by a common policy and full factor mobility, but the difference in shocks apparently points to structural differences in the economies of European countries.[12] Eichengreen and Bayoumi's results imply that there is a fundamental mismatch

[9] Bayoumi and Eichengreen (1992), 3
[10] Bayoumi and Eichengreen (1992), 7-12
[11] Bayoumi and Eichengreen (1992), 34-36
[12] Bayoumi and Eichengreen (1992), 36

between the "core" economies of Europe and the "periphery." This mismatch could be a result of different patterns of production, different labor productivities, or some combination.

A later study by the European Parliament conducted a thorough review of different asymmetric shocks in the context of the EMU, and concluded that European countries experience more sector specific shocks than country specific shocks.[13] Therefore, different economic sectors are likely to experience asymmetric shocks and if different sectors are prevalent in different countries or regions, these economies will suffer asymmetric shocks accordingly. The authors recognized that there are significant region-specific shocks, but argued that some of these would be smoothed out through expected the process of integration. They also recognized the significance of different financial structures between European countries, but argued that these would become less significant with integration, and increased capital mobility would provide another adjustment mechanism.[14]

The literature on asymmetric shocks is extremely important because most studies, including Eichengreen and Bayoumi's and the European Parliament's, found that European countries experienced asymmetric shocks and therefore did not meet Mundell's criterion for an optimal currency area. There have been different interpretations about what determines the presence of these asymmetric shocks. However, it seems clear that there were and are differences in patterns of production that result in asymmetric shocks. There could be differences in integration between different geographic regions or between economic sectors. In many cases there is a relationship between a certain sector which is especially important to a certain region, so that the region has a fundamentally unique economy that experiences unique shocks.

[13] Patterson and Amati (1998), 16
[14] Patterson and Amati (1998), 65

Therefore, the study of asymmetric shocks implies that the effectiveness of monetary policy depends at least in part, on the patterns of production of the economies to which it is being applied. Moreover, the European countries experienced significant asymmetric shocks before the creation of the EMU. The prevalence of asymmetric shocks suggests that there were structural differences between member countries that prevented them from achieving optimal conditions for a currency area.

Sectoral shocks that affect a specific economic sector, or industry, are types of asymmetric shocks that challenge even well integrated economies. Some recent academic literature has explored the ways in which sectoral shocks affect monetary policy. Overall, the theory about sectoral shocks follows a similar logic to that about regional shocks. If there is a shock that harms one specific sector of the economy, then optimal monetary policy will be different for that sector and for the rest of the economy. While the negatively affected sector would benefit from expansionary monetary policy, other sectors in the economy that are operating normally might not. Further, monetary policy might have different effects on sectors because there are different transmission mechanisms towards different sectors. For example, sectors might respond differently to a change in the interest rate because one sector might have more frequent investment needs. If a given sector needs to invest more frequently, it is more sensitive to changes in the interest rate.

In a paper by Raddatz and Rigobon, the evidence suggests that during the 2001-2002 tech crisis there were sectoral discrepancies in the effects monetary policy.[15] The Federal Reserve lowered interest rates in response to the recession caused by the dot com crash, but the tech

[15] Raddatz and Rigobon (2003), 1-3

sector does not seem to have benefitted from the lower interest rates because it has less need for investment capital. Instead, other sectors such as construction began to experience a rise in activity and eventually a bubble. Another study found that sectors that produce tradable goods, such as industrial goods, are more responsive to monetary policy because they are more sensitive to interest rates.[16]

These findings have interesting implications for economic integration because a lack of integration might increase the challenges of sectoral shocks. In a well-integrated economy, monetary policy might have some inefficiencies across sectors, but ultimately sectors will adjust to shocks.[17] However, a less integrated economy might have trouble adjusting because there is less mobility across sectors. With greater disparity between sectors, there is more difficulty in moving labor or other factors of production from one sector to another. In the context of the European Union, disparities in sectors are to some extent related to regional and national disparities. Countries within the EU have different patterns of production and significant differences in the role of particular sectors.[18] Therefore, sector specific shocks might have a similar effect to regional shocks by affecting some countries more severely than others. Without a large degree of integration, it becomes difficult for countries to adjust to sectoral shocks. It is also difficult for monetary policy to act effectively without very disparate effects on different countries.

There is a large body of evidence that monetary policy can have divergent impacts on different economic sectors, which also result in divergence that is not optimal for a currency area. Mundell's optimal currency area theory suggested that in many cases, national monetary

[16] Llaudes (2007), 5-6
[17] HM Treasury, The United States as a monetary union: EMU study (2003), 25
[18] Bayoumi and Eichengreen (1992), 6, 31

policy may not be effective for all regions in the area. Similarly, if there are disparate economic sectors under a single currency area, then a centralized monetary policy may not be efficient for all of them. In a normal currency area that spans a single nation, such as the USA, disparate sectoral effects may be smoothed out over time.[19] Just like asymmetric regional or sectoral shocks, a monetary policy with disparate sectoral effects will eventually be resolved through different adjustment mechanisms. For example, transfers by the federal government, intermediation by the financial sector, or movements between sectors and regions will eventually help to balance out asymmetric shocks. However, in a looser currency union like the EU, many of these adjustment mechanisms are not present. Therefore the disparate effects of monetary policy could be larger than in the U.S. case, and could aggravate the structural differences between parts of the currency area. Moreover, even for fully integrated currency areas, it is relevant to consider the inefficiencies that a monetary policy with divergent effects could have.

A number of studies have explored why different sectors have disparate policy needs. In an early example by Maisel, the evidence from the 1960s shows that monetary policies had different effects on the spending of sectors. Spending in the housing sector was especially affected, presumably because as a sector it is sensitive to changes in the interest rate. Other sectors that needed to invest to replace equipment also had a greater exposure to interest rate changes.[20] Later studies continued to explore how monetary policy is transmitted differently to different sectors. One analysis by the Bank of England reinforced the evidence that construction and manufacturing generally respond faster to a monetary shock than services.[21] Therefore, it might be reasonable to expect that a region or country within a currency area that has a larger

[19] HM Treasury, The United States as a monetary union: EMU study (2003), 43-44
[20] Maisel (1968), 813-814
[21] Ganley (1997), 27-28

manufacturing sector will respond differently to a change in monetary policy than a region with a larger service sector. Finally, there is evidence that smaller firms respond faster to monetary shocks than large firms.[22] These types of disparate effects underscore how differences in regional and sectoral structures affect the efficiency of monetary policy. Because the member countries and regions of the European Union have different patterns of production and costs, they experience very different shocks. These shocks may be asymmetrical changes in supply or demand, or even monetary shocks. EU policy therefore targeted the adjustment mechanisms that would let different sectors adjust to these shocks.

1.4: Adjustment mechanisms for asymmetric shocks

A second strand of literature focused on the response to asymmetric shocks and found that a currency area could still function optimally if its different economic regions adapt to the shock through labor market adjustments or through fiscal policy. In Mundell's example, the two regions have different patterns of production and cannot enact monetary or (to a large extent) fiscal policies to stabilize their economies. However, Blanchard and Katz claimed in a well-known paper that the regions might adjust to the shock through labor market movements.[23] If there is high unemployment in one region, then workers will have a strong incentive to just move to a different region where there is a shortage of labor.[24] Blanchard and Katz collected data for individual U.S. states and then studied the historical time series data for their main indicators like GDP and employment. The results indicate that there has been wide variation in output and employment over time throughout different U.S. states. In response to these shocks, states experienced changes in employment and wages. However, in the long run both employment and

[22] Peersman and Smets (2002), 6-7
[23] Blanchard and Katz (1992), 1-2
[24] Blanchard and Katz (1992), 54

wages returned to their natural trend. While the unemployment rate returned to its natural level, however, the actual level of employment changed permanently in response to shocks.[25] Therefore Blanchard and Katz's results suggested that in the long run, economic regions adjust to asymmetric shocks through changes in the labor market. When one region of a monetary union suffers an asymmetric shock, it cannot adjust through changes in monetary policy or currency values. Instead, it can adjust through factor mobility, particularly labor. Workers will leave the affected area in response to a sudden shock, until unemployment and wages return to their natural trend. These results imply that even if Mundell's conditions for an optimal currency area are not met, in the long run a currency area can function optimally if its component areas have enough factor mobility to adjust to shocks. Therefore monetary policy could still function optimally over a geographic area with disparate patterns of production and costs if these structures are able to respond effectively to shocks.[26] With enough mobility of factors of production, especially labor, regions can adjust to asymmetric shocks. However, it is likely that an adjustment through factor mobility will take more time than a monetary policy response. Blanchard and Katz' results suggest this greater time lag. In the context of the European Union, policymakers and economists quickly identified factor mobility as an essential part of the EMU's future success. The member countries' structural differences were evident enough to direct much of the focus onto integration measures to ensure factor mobility.

The second main adjustment mechanism that can absorb asymmetrical shocks is a fiscal policy controlled by federal authorities. If a currency area also has a unified federal authority with fiscal powers, then fiscal transfers can alleviate asymmetrical shocks. When one region

[25] Blanchard and Katz (1992), 41-43
[26] Bayoumi and Eichengreen (1992), 2

suffers a negative shock, for example, the central government may enact expansionary fiscal transfers to absorb part of the shock. Although estimates vary, different studies have calculated that fiscal transfers can absorb between 10% and 40% of an asymmetric shock that negatively affects one region of a currency area.[27] Most of these studies concern fiscal transfers in the US, because the EU did not create a fiscal union for its members. One study estimated that in individual European countries, fiscal transfers play an even greater adjustment role than in the US.[28] However, these mechanisms do not exist at the European level and they cannot absorb asymmetric shocks that affect some countries but not others.

1.4: Conditions for an optimal currency area

An optimal currency area requires synchronized business cycles and similar economic structures across its members, or robust adjustment mechanisms. Mundell's theory of optimal currency areas dealt with the need for similar economic structures, or patterns of production, across its members. Similarly, the component regions of an optimal currency area need to have synchronized business cycles. A unified monetary policy will clearly not be optimal if part of a currency area is experiencing an expansion while another goes through a recession. Convergences or divergences in patterns of production and business cycles are usually reflected in indicators such as GDP, inflation, and exchange rates. Therefore an optimal currency area presumably requires similar levels for these key indicators.

Large currency areas, such as the United States, have disparities in the business cycles and patterns of production of their regions but rely on flexible adjustment mechanisms to remain

[27] Bajo-Rubio and Diaz-Roldan (2003), 8
[28] HM Treasury, The United States as a monetary union: EMU study (2003), 71

successful.[29] In fact, Eichengreen and Bayoumi's work found that output variations were larger in the eight regions of the US than in comparable Eurozone regions. However, regional variations were somewhat more synchronized with each other in the US than in the EU.[30] One particularly relevant adjustment mechanism is labor market mobility. Blanchard and Katz's work shows the important role of labor mobility in adjusting for asymmetric shocks through migration out of a region. This adjustment mechanism is also weaker in Europe, with a study by the Center for European Policy Studies finding that the rate of mobility for the US is about ten times higher than the EU's. European labor mobility is low both within and across member states.[31] Fiscal transfers are the other important adjustment mechanism in the United States, but do not exist at the European level.

For a currency area such as the European Union without fully developed adjustment mechanisms, the structural requirements for an optimal currency area become more important. Asymmetric shocks pose a large risk to the stability of the currency area, so the main requirement for optimality is to prevent them. Additionally, the starting conditions of each member when they join the currency area have to be similar. If members have very different monetary policy needs when they join the union, then a unified monetary policy runs the risk of provoking a crisis in certain areas. The empirical literature shows that monetary policy can have contradictory effects in different regions or sectors, like US policy after the dot com crisis. The parts of a currency area should have similar economies to make sure they have the same monetary policy needs, and to minimize asymmetric shocks. There are a few indicators of convergence or divergence between the economic structures of member parts. They include

[29] HM Treasury, The United States as a monetary union: EMU study (2003), 43-44
[30] Bayoumi and Eichengreen (1992), 19-21
[31] Barslund and Busse (2016), 3

factors such as inflation rates, real exchange rates, real interest rates, and structural factors such as the business geography of a region.

The second important requirement for an optimal currency area are the adjustment mechanisms that could help to smooth out asymmetric shocks. There are some important economic mechanisms that can resolve imbalances by transferring resources from one sector or region to another, and therefore account for asymmetric effects. In the United States, the most important adjustment mechanisms are fiscal transfers by the national government and labor mobility. In the case of the European Union, a fiscal union was rejected by voters and policymakers in some European countries. The EU adopted a so-called Cohesion Policy, which makes limited fiscal transfers to promote long term convergence but is not intended as a mechanism to address shocks. The European Single Market implemented labor mobility and capital mobility between European countries, although it has limitations.

In the absence of adjustment mechanisms like fiscal transfers and high labor mobility, the most important determinant of a currency area's optimality is the similarity in the business cycle and patterns of production of its members. The members of the European Union have significant differences in both of these fields. A historical account of how these policies and the institutional arrangement of the monetary union came about will help identify the causes for its divergence from an optimal currency area.

2: The European Monetary Union and its differences from an optimal currency area

The historical evolution and institutional organization of the European Union reveal the areas where it diverges from an optimal currency area. This section of the essay will examine the structure of the EU's economic and monetary union through the historical evidence and relevant documents. This historical evidence contains economic insights that will be corroborated through empirical analysis later in the essay. The first part of this section outlines the relationship between political and economic factors that led to the development of the EU helps frame the analysis. Then, there is an overview of the political process towards European integration which was the primary driver for economic integration. A review of the economic policies that were enacted to achieve integration showcases how economic decisions were subordinated to political concerns. The documents that came out of this interplay of political and economic factors created the framework for Economic and Monetary Union: the Delors Report and the Maastricht Treaty. An analysis of these documents shows the areas where the EMU diverges from an optimal currency area. Finally, these areas of divergence will be identified as historically mismatched currency values, different patterns of production, and absent adjustment mechanisms. The theoretical conclusions of this historical analysis will be tested empirically in the final part of the essay.

In the complicated language of the European Union, the structure of economic integration is known as the Economic and Monetary Union or EMU.[32] The process leading to EMU started in the 1950s after the Second World War. As a series of political debates and decisions over the following decades, the integration process intensified gradually. During the 1980s European

[32] Delivorias (2015)

leaders made the decision to push for a full economic and monetary integration. The Maastricht Treaty of 1992 created the structure for Economic and Monetary Union. This structure included the creation of the European Central Bank in 1998 and the adoption of the Euro as a single currency in 1999.[33]

2.1: Political origins of European Monetary Union

The European Union was the result of a long political process which European countries decided to undertake after the Second World War. Economic integration was the trigger, and for many years the cornerstone, of the European integration process. However, economic integration never had purely economic motivations. Much of the drive towards the economic union came from politicians who envisioned an economic union as a guarantee of peace on the European continent. Therefore, the history of European economic integration is intertwined with the political debates of 20th century Europe. It can be difficult to analyze economic policies independently of other political considerations, so it is important to place economic integration in its historic political context.

The creation of the European monetary union grew out of a political decision to embrace greater integration and economic policies designed to limit exchange rate instability between European currencies. These two main currents complemented each other because European leaders came to see economic integration as a boost to their monetary policies as well as a political symbol of unity.[34] Towards the end of the unification process, policymakers also emphasized the benefits that a single market would have for economic growth. However, the roots of the monetary union date from the 1957 Treaty of Rome. The creation of the European

[33] Delivorias (2015)
[34] Marsh (2009)

Economic Community was the first important milestone on the road to European integration, lowering tariffs and enshrining the ambition for an "ever closer union".[35] This concept of ever closer union had a clear political motivation to protect peace in the post-World War II years. The European Economic Community functioned as a guarantee of peace by binding European economies closer together. There was also a recognition of the economic links between the most important European economies, France, West Germany, and Italy. Establishing a framework to manage these linkages could help ease political tensions.

The close economic links between France and Germany provided an additional political impetus to the integration project during the 1970s. The two nations experienced severe exchange rate instability, as will be seen in the economic history of European integration. Policymakers in both nations recognized that their economies were so closely linked together that the currencies needed to remain at relatively similar exchange rates. The efforts to keep the French franc and the German Deutschmark relatively stable against each other produced decades of political tension between France and Germany. A monetary union eventually came to be seen as the most effective political tool to end exchange rate instability.[36] Other core European economies, like the Netherlands and Italy, also supported integration to stabilize their exchange rates.[37] The Netherlands showed early support for economic integration, partly because it was already a very open economy. Italy also supported integration while occasionally voicing concerns about the need for economies to converge before achieving monetary union. Italy had a

[35] Marsh (2009), 13
[36] Marsh (2009), 81
[37] Chang (2009), 22

consistently higher unemployment and inflation rates, and feared giving up its monetary policy to low-inflation economies like Germany.[38]

Finally, during the 1980s and 1990s the decisive push for monetary union was a result of political concerns over German monetary dominance and reunification. The German Bundesbank was so dominant during the 1980s, for reasons that will be explored shortly, that it effectively set the monetary agenda for Europe. Therefore, French policymakers believed that a monetary union that established a European Central Bank could help France retain some influence on monetary policy.[39] All countries would have a say in a united monetary policy, whereas the Bundesbank's decisions unilaterally impacted the rest of Europe and often posed political problems. When West Germany reunited with its Eastern counterpart in 1990, European policymakers feared that the new Germany would stray from its role in the post-war European order. At the same time, German political leaders wanted to reassure their European counterparts by showing their commitment to the European political order. This commitment would legitimize Germany's push for reunification and gain support from the other European states. Monetary union therefore became a part of a large political plan for integration that fulfilled Europe's political as well as economic objectives. In this political context, the economic policies that integrated Europe prove to be part of a larger diplomatic plan. It becomes clear why the structure of the economic and monetary union that emerged from the political process sometimes diverged from an optimal currency area.

[38] Chang (2009), 19
[39] Marsh (2009), 80

2.2: Economic Factors of European Monetary Union

European countries decided to form a currency area in order to stabilize their exchange rates, coordinate their monetary policy, and increase trade by deepening the Single Market. In the years of the Bretton Woods system, concerns over exchange rate fluctuations first caused European countries to evaluate the possibility of a monetary union. In particular, the monetary divergence of France and West Germany raised fears of currency instability and set a pattern that lasted for the following decades. The instability spread to other European currencies and smaller countries also came to support integration. The currency fluctuations also made trade and business transactions more difficult. The Bundesbank, which directed West German monetary policy, had a very significant effect on monetary policy throughout Europe by the 1980s. Therefore France, as well as countries like Belgium and Italy, believed that a unified monetary policy for Europe would achieve better results than attempting to coordinate their policies with the Bundesbank unilaterally. During the 1980s European policymakers also became convinced that opening and integrating European economies with one another would boost trade and growth in Europe. The plan for economic and monetary union developed out of this desire to achieve a stable and coordinated monetary policy along with deeper integration.

The plan for European monetary integration was a response to the spike in monetary instability caused by the collapse of the Bretton Woods system in the early 1970s. In response, European leaders created the European Monetary System, which functioned as a soft peg where currencies fluctuated within a certain band of each other. These early steps of European monetary union were designed exclusively with the objectives of political and currency stability. The collapse of Bretton Woods risked massive fluctuations in European currencies, caused by factors like the divergence between the Bundesbank's tight monetary policy and the Banque de

France's relatively loose policy. The Bundesbank considered a low inflation rate to be its sole and indispensable objective. Therefore the value of the Deutschmark remained consistently high against the French franc, which weakened as a result of loose monetary policy.[40] In turn, these differences might cause economic problems if German firms suddenly lost competitiveness, or France experienced high inflation. These types of economic problems could be blamed on other European states and increase political instability. The European Monetary System and the "Snake" system of exchange rates which it used for a decade, were created to solve these political and currency issues. They were not created with an optimal currency area in mind of the type which Robert Mundell envisioned.

The first proposals for monetary union around 1970 met with disagreements over whether the ERM system should lead to a full economic and monetary union. Some policymakers raised the types of objections about regional divergences that OCA theory suggested. Countries such as the Netherlands took a strict view that European economies needed to converge before a full monetary union was considered.[41] Even in later years when Europe was on the road to a monetary union, countries like France enacted monetary policies designed to defend the stability of their currency and not to optimize for domestic growth or employment.[42] Another difference in economic ideology developed with important implications for the future of monetary union. In general, French policymakers believed that if European countries achieved political and economic integration first, then this integration would bring about the convergence between their different economies to make the union sustainable. However, the Germans believed that any

[40] Marsh (2009), 64
[41] Chang (2009), 23
[42] Marsh (2009), 168-181

integration had to wait until economies converged to the necessary level.[43] These debates show that European policymakers were aware that differences between European economies could threaten the stability of a currency area.

Enthusiasm for closer integration built throughout the late 1970s and 1980s mainly as a response to growing German economic strength. Throughout this time period, the UK kept its distance from proposals for monetary integration due to fears that its much weaker currency and high inflation rate would make it vulnerable to speculation in foreign currency markets.[44] This fear reflected an implicit recognition that the British and German economies were so divergent that they could not effectively run a common monetary policy. During the decades after World War II, all the major European states resented the preponderance of the dollar and the excessive impact of US monetary policy on their economies. This desire to gain monetary independence versus the US and major economies like Japan provided another undercurrent towards European monetary union.

During the 1980s, political and economic arguments for monetary union gained traction as the Single Market was established and German strength increased. Economic integration preserved France's importance on the continent, while political integration would legitimize Germany's return to the political stage. Secondly, the 1980s and 1990s saw a recurrent series of monetary conflicts between France and Germany over the value of their currencies. There were increasingly bitter confrontations about the strength of the Deutschmark and the instability of the franc, and their destabilizing effects on European economies. Full economic and monetary union was designed to smooth out this turbulence. At the same time, European countries came to

[43] Marsh (2009), 183
[44] Marsh (2009), 139-149

support the creation of a Single Market which would lower tariffs, and benefit the whole continent through increased trade. The Single Market was expected to increase trade and capital mobility between European economies. Greater capital movements might cause more instability, and a monetary union was seen as a way to stabilize currency values threatened by large capital flows.[45] As a result of these converging forces, the Delors Committee kickstarted the debates about full economic and monetary union which culminated with the Treaty of Maastricht in 1992. These debates included comprehensive analyses of the economic consequences of EMU.[46] The economists and policymakers who participated in them created the institutions and policies of EMU to function as optimally as possible. However, the history of the political road to the Treaty of Maastricht underscores that the creation of an optimal currency area was not the primary motivation for the creation of the European monetary union.

The recent history of the EU after the 2008 financial crisis makes the structural issues with the union very clear. The 2016 Brexit vote was the first case of a member country deciding to leave the Union, although the United Kingdom was never a member of the Eurozone and the monetary union was not a primary factor in its decision to leave. The Southern European debt crisis, the Northern European reluctance to transfer fiscal resources, and the rise of anti-European populist parties in countries like France and Italy all point towards the structural flaws in European monetary union.[47] During a speech in 2011, ECB President Jean-Claude Trichet identified the divergences in competitiveness between European countries as one of the main structural risks for the European monetary union. Unit labor costs increased throughout the

[45] Chang (2009), 38
[46] Delors (1989)
[47] Marsh (2009), 1-11

Eurozone, but they increased at a greater pace in countries like Greece and Ireland.[48] These divergences will be further explored later in the essay. However, the crisis exposed their harmful effects on the functioning of the EMU. Even though the initial crisis was not itself an asymmetric shock, because all countries suffered a negative shock, its effects were asymmetric.[49] Current account imbalances likely played a role in the crisis by promoting credit bubbles in countries like Spain and Greece. These current account imbalances were partly a result of divergent real effective exchange rates in different countries. Additionally, the low labor productivity in Southern European countries aggravated the crisis there and made it more difficult for them to recover.[50] These difficulties in adjustment are to some extent rooted in the institutional framework of the EMU.

2.3: Institutional Framework of the European Monetary Union

2.3.1: The Delors Report

The Delors Report of 1988 set the framework for Economic and Monetary Union as a guarantee of stability and growth, and placed the single currency at the heart of this project. Once the European Commission confirmed the goal of achieving Economic and Monetary Union for Europe, it created a committee including the governors of the European Community's central banks, other experts and chaired by the chairman of the European Commission, Jacques Delors. Even though many of these policymakers shared the traditional divisions between French and German monetary policy, and other recurring disagreements, they produced a detailed guide towards EMU.

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[48] Trichet (2011)
[49] Boltho and Carlin (2012)
[50] Levy (2012)

The Report rooted the motivations for EMU in the instability of exchange rates after the collapse of Bretton Woods, and the desire of European countries to maintain exchange rate stability.[51] The European Monetary System had already achieved partial monetary integration, but a closer monetary union would help stabilize exchange rates, and price levels through monetary discipline. The report identified the divergence of economic policies in European countries, especially fiscal policy, as a drag on the effectiveness of monetary integration. The creation of an EMU offered a way to solve these divergences.

The Delors Report stated that the Single Market and the economic movements it caused could only be managed effectively through a unified monetary policy. Then the report went on to outline the official definition of the monetary union it envisioned: "a currency area in which policies are managed jointly with a view to attaining common macroeconomic objectives".[52] This area would have some key characteristics including the "irreversible convertibility of currencies," complete liberalization of capital, and the "irrevocable locking of exchange rate parities." Although these objectives could be achieved without an official single currency, it made sense to introduce the single currency that became the Euro. Accordingly, the new monetary union needed a common monetary policy to manage the currency directed by what became the ECB.

In parallel to the monetary union, the Delors Report advocated for an economic union defined as an unrestricted common market with a common set of rules. The monetary and the economic aspects of the union were seen to be completely intertwined. Crucially, the Report acknowledged that the loss of monetary independence for the different countries of the union

[51] Delors (1989), 7
[52] Delors (1989), 25

might lead to economic imbalances. The Report correctly identified the causes of these imbalances as the structural impacts of a common market, cost differences, asymmetric shocks, and divergent national economic policies. After this comprehensive evaluation of the types of imbalances that might arise, the Report offered a more limited set of possible solutions. The most important suggestions were measures to improve the mobility of factors of production, and flexibility of prices. Finally, the Report recognized the crucial importance of maintaining relatively similar economic policies at the national level. Especially in terms of fiscal policies, which could become an important source of imbalances.

2.3.2: The Treaty of Maastricht

The Treaty of Maastricht incorporated the Delors Report's guidelines into a binding agreement to achieve EMU within a decade. By 1991, European leaders were mostly on board with the project for a closer union. While the Treaty of Maastricht had important political effects that updated the Treaty of Rome and established new European institutions, its most important impact was the creation of EMU. The Maastricht Treaty embraced the guiding principles of the Delors Report about the necessity for monetary union.[53] Most importantly, the leaders who convened at Maastricht decided to set the single currency as the final goal of monetary union.

Therefore, the Treaty embraced the creation of the Euro and the central bank which the Delors Report had proposed as options. While the Delors Report had only proposed a system to unite the existing European central banks into a coordinated system, the Maastricht Treaty laid out the creation of a totally new European Central Bank.[54] This measure was relevant because the system of European central banks would have had greater political oversight and

[53] Marsh (2009), 126
[54] Council of the European Communities. (1992). Treaty on European Union

interference. Instead, the European Central Bank was explicitly created to be as independent as possible from political pressures, following the model of the Bundesbank. The ECB's independence meant that its policy would be more credible and achieve greater price stability, but also much more inflexible in responding to the needs of particular countries.

The parties at Maastricht recognized that there needed to be a certain level of convergence among the European economies before the adoption of the Euro. As a result they set out a series of criteria for countries to be admitted into the monetary union and the single currency.[55] Most importantly, there were limits on each country's budget deficit, inflation rate, interest rate, and debt levels. The budget deficit was capped at 3% of GDP, and countries would presumably not enter the monetary union if they did not meet this criterion. Additionally, a member country's debt could not exceed 60% of its GDP. Morevoer, the Treaty limited the Union institutions and the ECB's capacity to bail out nations that ran into difficulties, in an attempt to minimize moral hazard problems.[56] However, the Maastricht convergence criteria led to a series of disputes about how much convergence the monetary union would requires. Crucially, the Treaty did not establish a binding political union, meaning that there was not a binding union on national economic policies, except for a suggestion that they should be "coordinated" with the European authorities and other countries.[57] Finally, the Maastricht Treaty was innovative by creating a Cohesion Fund designed to promote poorer European regions and facilitate their convergence with the richer part of the continent.[58]

[55] Council of the European Communities. (1992). Treaty on European Union
[56] Chang (200), 53
[57] Council of the European Communities. (1992). Treaty on European Union, 172
[58] Baun and Marek (2014), 28-29.

The Treaty of Maastricht was signed and ratified by all the members of the European Community, although the United Kingdom and Denmark opted out of the full Economic and Monetary Union. Accordingly, the Treaty set a timetable for full monetary union which depended on the convergence criteria. While the exchange rates of European currencies were irrevocably fixed during "Phase I" of the Maastricht process, subsequent integration would only happen if the criteria were met.[59] The German authorities were convinced that some convergence needed to happen before the union was locked in, while other countries expected convergence to happen as a result of union. There were disagreements about how to measure convergence, so the political leaders at Maastricht chose nominal indicators like the deficit, inflation, and debt. This decision was important because there were underlying conditions that were not taken into account and arguably played a more important role in structural convergence. For example, Germany's moderate wage growth played an important role in keeping its inflation down and its currency valuable compared to France or Italy. Germany's cost structure also helped keep its exports competitive and contributed to the strength of the Mark.

Therefore, constraining countries' public spending and monetary policy in the years before the Euro may not have been enough to ensure convergence. Many countries then broke the convergence criteria, which pushed the timetable for full EMU from 1997 to 1999.[60] Even though European leaders held the threat of excluding some countries when they made the final decision in 1998, no country was left out. There were doubts about the accuracy of some countries' figures throughout the process, such as Greece. Moreover, countries took extraordinary measures in order to decrease their spending in the two years before union in 1999.

[59] Chang (2009), 48
[60] Marsh (2009), 190-204

When these temporary measures expired, they returned to their previous pattern of spending in spite of the Stability and Growth Pact that was intended to lock governments into fiscal discipline.[61] Ultimately, many policymakers were aware of the difficulties in meeting the Maastricht criteria, but the political necessity of completing the process took precedence over the economic warnings. The Treaty of Maastricht and the subsequent process of unification underscored the divergence between European countries but also their potential to converge.

2.4: The European Monetary Union's divergence from an optimal currency area

The institutional design and creation of Europe's Economic and Monetary Union incorporated some features of an optimal currency area, but the members had different monetary policy needs as a result of different patterns of cost and production. At the moment when the European Union adopted a single monetary policy and unified currency, the economies of its members had fundamental divergences from each other.[62] Countries in the European periphery experienced different shocks from core economies, had different labor productivities and structurally higher inflation. These divergences in cost and production meant that a single monetary policy was not optimal for the member economies. However, the fact that the Economic and Monetary Union was not an optimally functioning currency area does not necessarily mean that it was a failure. The European Union was not designed to match all of Mundell's criteria for an optimal currency area. Throughout the history of European integration, there were other motivating factors which were arguably more important.

The most important was the desire to achieve political integration and safeguard peaceful cooperation between European countries. As discussed previously, exchange rate stability and

[61] Chang (2009), 54-56
[62] Bayoumi and Eichengreen (1992), 35-36

coordinating monetary policy were the other main goals of monetary union. With those objectives in mind, the European monetary union did give a greater voice to non-German policymakers although the ECB has remained very independent of political authorities.[63] The introduction of the single currency clearly eliminated exchange rate instability among European economies. The most important drawback to the monetary union was the loss of policy flexibility and exchange rate adjustment mechanisms, as Mundell had already pointed out. The lack of adjustment mechanisms meant that monetary policy would have different and counterproductive effects on different parts of the European Union, as Mundell pointed out in his example of a region suffering from a recession versus a region with high inflation.[64]

Moreover, the lack of exchange rate flexibility meant that the single currency might be valued too highly for some countries and cause their exports to lose competitiveness. Alternatively the currency might have been undervalued for some countries and caused inflationary pressures, but the ECB's policy effectively opted for a strong currency rather than a weak one. As early as 2007, the vice-president of the ECB recognized the danger of divergences in competitiveness between European countries. Vice President Papademos argued that divergences in unit labor costs drove the differences in inflation rates and competitiveness between European economies. While the differentials in inflation rates of European countries are similar to those in the US, they persist for a longer time. Papademos argued that unit labor cost divergences drove these persistent inflation differentials that undermined the competitiveness of some countries.[65] As some countries experienced higher inflation than others, some economists argued that their effective exchange rates would also diverge. Divergent effective exchange rates

[63] Marsh (2009), 218-220
[64] Mundell (1961), 658-659
[65] Papademos (2007)

in different regions can lead to current account imbalances as some regions get a boost to exports and others lose export competitiveness. These imbalances widen the gap between what monetary policies each region would prefer. Divergences in competitiveness increase the likelihood of countries being affected differently by asymmetric shocks and lead to further divergences in optimal monetary policies for different countries.

Comparing the EU with Mundell's optimal currency area reveals two main problems in its structure as a monetary union. First, the economies of individual member countries have significant differences in price levels, real exchange rates, and real interest rates. Second, their economies diverge due to different cost and production patterns. These structural differences feed into the nominal indicators of divergence such as the price and exchange rate levels. There is no conclusive proof that the European Union does or does not function as an optimal currency area, or that it is partly optimal. Some scholars argued that member countries of the EU would only enter into a currency union if its benefits outweigh its costs. If the beneficial effects of currency union, such as increased trade, are greater than its drawbacks then the union is optimal for its members.[66] A historical overview of the EU's creation reveals that the monetary union was not designed to exactly match Mundell's criteria for an optimal currency area. However, European leaders were aware of the economic differences which could threaten the functioning of the currency area.

The Delors Report which created the framework for European monetary union identified the problems with structural divergence in European economies and contradictory national policies. When the Maastricht Treaty established the European Union in 1992, some of these

[66] Talani (2009), 13

concerns were addressed. The convergence criteria were an attempt to synchronize the economic policies of different countries.[67] In order to solve the deeper structural differences of cost and productivity that gave rise to asymmetric shocks, the Treaty relied on the process of economic integration. Scholars and policymakers like ECB President Jean-Claude Trichet predicted that greater integration in financial markets and labor markets would lead to convergence or at least help with adjustment to shocks.[68]

The evidence from US regions showed the importance of labor market flexibility and migration in adjusting to asymmetric shocks. The European treaties opened borders and established labor movement across the EU at a basic level. However, European labor mobility has remained significantly lower than in the US. There are likely both juridical and cultural reasons for this difference. Some legal obstacles remain, such as barriers to professional qualifications and movement of social benefits.[69] There are also major cultural obstacles to mobility, such as the diversity of languages spoken in Europe. The aging of the population and the rise of double-income households also make mobility more difficult. The recent Eurozone crisis destroyed the availability of jobs in some areas and discouraged movement there.[70] Other studies suggested that integrated financial markets could transfer capital in ways that helped adjust to asymmetric shocks between regions. Mundell himself supported his view in his later work.[71] Finally, the Treaty of Maastricht outlined a Cohesion Policy that called for small scale fiscal transfers to the poorest regions of the EU. These funds would be used on infrastructure and other projects aiming to improve productivity.

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[67] Council of the European Communities. (1992). Treaty on European Union
[68] Trichet (2007)
[69] Zimmermann (2009), 3
[70] Zimmermann (2009), 10
[71] Talani (2009), 18

In summary, the European monetary and economic union was created to reinforce political integration and stabilize currency exchange rates. It was not created to be an optimal currency area, but comparing the EU's architecture to an optimal currency area reveals a lack of economic convergence and adjustment mechanisms. European leaders were aware of some of these structural flaws, and addressed them with three main policies in the Treaty of Maastricht. First, the convergence criteria attempted to synchronize national economic policies enough to successfully launch the monetary union. Second, closer economic integration especially of financial and labor markets, was intended to create more flexible adjustment mechanisms in case of a shock. Finally, the Cohesion Policy set up some fiscal transfers to facilitate structural convergence of the poorest regions of the EU. The convergence criteria quickly ran into political difficulties. Countries may have obfuscated their data to meet the criteria in the short term. After a few years, even the most important countries abandoned the fiscal criteria and they never served to achieve long term convergence. Therefore, the responsibility for convergence fell on the policies of economic market integration and cohesion. It is important to analyze these two areas of policy, as well as the relevant indicators of monetary convergence, to understand whether the EU has drawn closer to an optimal currency area.

3: Measuring convergence towards an optimal currency area

The areas where the European economic and monetary union diverges from an optimal currency area can be illustrated more clearly through empirical analysis. This essay will therefore conclude with an empirical analysis of convergence towards an optimal currency area. First, a discussion of the broad structure explains why it is necessary to focus on the indicators of convergence that follow from optimal currency area theory. The analysis will examine variables that explain convergence or divergence from the conditions of an OCA. Then a stylized overview of the indicators goes over the main factors of convergence and divergence: exchange rates and monetary policy, patterns of production and business cycles, and adjustment mechanisms. The main challenge in evaluating these data is the large number of different variables which can be measured but are related with each other. Therefore the chosen methodology is to conduct a factor analysis of the possible variables that can indicate convergence towards an optimal currency area, followed by a case study of one application for the indicators. The types and sources of data from the Eurostat agency will be outlined. The essay will conclude with a detailed explanation of the results and their implications.

3.1: How to measure the optimality of a currency area

There is no single way to measure economic divergence or convergence. However, it is useful to leverage the wide range of European statistics available to approach some indicator of convergence. The large number of different statistics that the EU collects and the lack of a single methodology means that there are important assumptions and choices to make. The most common measure of convergence is GDP per capita. GDP per capita is commonly used to measure the convergence of subnational regions within the union, because it is fairly useful as a measure for quality of life. However, GDP per capita is not necessarily the best and certainly not

the only indicator of convergence. In particular, the optimal performance of the EU as a currency area does not necessarily depend on having a uniform GDP per capita across countries and regions. Optimal currency area theory illustrates how an optimally functioning currency union requires more than similar levels of GDP across its component regions.[72] Elements such as the price level, business cycle, patterns of production, factor markets, and adjustment mechanisms are equally important, and they have been the main subject of studies evaluating whether the EU qualifies as an optimal currency area. The United States, which is often the standard of comparison for the EU's monetary performance, has significant differences in GDP across its regions[73] but performs relatively well as a currency area thanks to its adjustment mechanisms in labor and other factor markets.[74] The EU does not have equally strong adjustment mechanisms, so its convergence depends on whether the members have similar business cycles and patterns of production. Therefore, the following analysis will focus on indicators of structural convergence towards an optimal currency area. Indicators of convergence will be studied in light of their implications for an optimal currency area, and not for convergence of living standards.

The history of the EU reveals some important factors that may serve as indicators for its distance from an optimal currency area. The first is the difference in currency exchange rates due to divergent monetary policies. One of the most important historical reasons for the creation of the European economic and monetary union was the struggle to maintain exchange rate stability. European policymakers wanted to keep their currencies, particularly the French franc and the Deutschmark, relatively similar in value to facilitate trade.[75] However, differences between

[72] Bayoumi and Eichengreen (2009)
[73] In 2014, GDP per capita was $54,629 in the US. North Dakota had the highest GDP per capita, with $72,719. Mississippi had the lowest GDP per capita, with $34,784. (http://www.aei.org/publication/us-gdp-per-capita-by-state-vs-european-countries-and-japan-korea-mexico-and-china-and-some-lessons-for-the-donald/)
[74] HM Treasury, The United States as a monetary union: EMU study (2003)
[75] Marsh (2009)

countries with tight and loose monetary policies meant that exchange rates were constantly diverging. These differences in exchange rates indicate a number of structural differences that make currency union more difficult. They indicate a mismatch between economic regions with a strong export industry and those with weaker exports, a mismatch between looser and inflationary monetary policies and tighter policies, and divergences in price levels across different regions. A second historically important factor is the divergence in patterns of cost and production that cause different business cycles across countries. As Eichengreen and Bayoumi pointed out, European countries experienced asymmetric shocks to their economies. European countries had different patterns of production[76], so they tended to suffer different shocks at different times. As a result of different shocks, countries and regions experienced asynchronous business cycles that meant one country was growing while another was suffering a downturn and they required different monetary policies.[77] Finally, European leaders expected to address these issues by promoting adjustment mechanisms that enabled labor and capital markets to smooth out shocks. The Single Market policies were expected to make labor and capital markets more flexible and integrated. Evidence from the United States suggested that capital markets could help absorb a significant portion of shocks, and that labor mobility was a major contributor to smoothing out shocks across regions. Therefore, flexibility and liberalization in factor markets constitutes an important element of the EU's optimal functioning.

The main challenge in measuring convergence towards an optimal currency area is the large number of indicators. The broad areas in which the EU diverges from an optimal currency

[76] For example, in 2016 the Czech Republic employed 27.6% of its population in manufacturing while the Netherlands employed 9.5% in manufacturing (Eurostat: Employment in technology and knowledge-intensive sectors at the national level, by sex (from 2008 onwards, NACE Rev. 2)
[77] Bayoumi and Eichengreen (1992), 34-36

area, exchange rate and price level differences, structural economic differences and factor market imperfections, can all be measured in a number of different ways. Moreover, there are other indicators that may be useful, such as GDP itself, or growth rates. It is impractical to analyze all of these indicators at the same time.[78] Another major difficulty is that many of these measurements are related to each other and affect each other whenever there is change in one of them. An improvement in labor productivity could improve the export competitiveness of an economy and strengthen its real exchange rate. Finally, there could conceivably be underlying factors that are difficult to observe and move some or all of these variables at the same time. A number of historical structural flaws, like asynchronous business structures and lack of adjustment mechanisms, and nominal values such as price levels and GDP indicate the EU's divergence from an optimal currency area. All of these factors aggregate into a rough picture of the EU's distance from an optimal currency area. Therefore, the first part of this analysis will use a method of factor analysis which helps to sort through a number of different indicators. Factor analysis assumes that there are unobservable factors that impact several indicators at the same time. After performing factor analysis on the set of indicators of convergence, the results will show which of the indicators are explained by each factor and how much of the total variance they explain. Different indicators will be grouped by their corresponding factor, and the list will be narrowed down to the most relevant indicators of convergence.

3.2: Methodology[79]

The analysis will consist of two parts. First, there will be an analysis of the indicators of convergence or divergence towards an optimal currency area using a factor analysis model. The

[78] Diebold and Rudebusch (1994)

[79] See Appendix A for a more extensive discussion of the factor analysis methodology, drawbacks, and use in this essay

factor analysis model will use a set of eight to twelve different variables that could measure convergence towards an optimal currency area. The results will illustrate which of these variables are correlated with each other and how much variance they explain in the full dataset. Three of the variables will be picked as the most important indicators of convergence. The second and more brief part of the analysis will test one practical application of these indicators using Poland as a case study. The three main indicators will be compared to the Eurozone average to determine how much convergence of divergence there is with a potential entrant to the monetary union like Poland.

3.2.1: Data Sources

The data for this analysis have been collected from the Eurostat database. Eurostat is the official statistical agency for the European Union and published a wide variety of social and economic statistics. Eurostat also compiles a number of indices for economic indicators, some of which will be used in the analysis. The data includes economic figures at the national and regional level for the 28 member countries of the EU as of 2018. The figures generally date back to 1995, although some variables include older data.

3.3: Factors of monetary convergence:

A factor analysis of different economic indicators offers useful insight into the factors of convergence towards an optimal currency area. The factor analytic method will narrow own the broad list of indicators to the ones that best reflect the important underlying factors of convergence towards an optimal currency area. The method of factor analysis has some drawbacks, so three different versions of the analysis will be performed to minimize errors. The first analysis is a basic form of factor analysis using national data for the 28 countries of the

European Union, for data from 2015. The analysis covers the entire European Union and not just the Eurozone. The other countries of the EU are also integrated with the European economy, so their economic data provides additional useful observations about the relationships between the whole continent. It is also useful to have as many observations as possible for the factor analysis to be more accurate. 2015 is the latest year for which there is data from all the main variables. Then the same analysis is performed with data from 2005, in order to verify whether there are significant differences over time in the results. The analysis is then repeated using regional data from 2015, which contains a much larger number of observations.

The simple analysis uses national data to estimate the main factors of convergence towards an optimal currency area. The variables chosen are based on the conclusions of optimal currency area theory and EU history. The variables express the possible divergences in prices, exchange rates, and interest rates which OCA theory identifies as important. The later regional version also includes a measurement for the business geography of the region. As a group, the variables indicate whether different regions have similar monetary policy needs. They reflect some aspects of the short-term business cycle, such as inflation, but GDP is not included. Most of the variables are chosen to reflect patterns of production and cost. The results of the analysis will group some of these variables together according to the underlying factors that affect them at the same time. The most relevant variables will be considered as the main indicators of convergence towards an OCA. The variables chosen for the first part of the analysis were:

1. **Nominal effective exchange rate** (measured as an index for each European country where each country's value for 2011=100, not deflated)
2. **Real effective exchange rate** (measured as an index, where the exchange rate value of the Euro in each European country in 2011 = 100, deflated by the consumer price index of each country)
3. **Ratio of total exports over total imports** (calculated at the national level)

4. **Long term bond yield** (measured according to the Maastricht convergence criteria, based on the long term yield of government bonds for each European country)
5. **Labor cost** (measured as the average of total compensation per worker, indexed for each European country in 2011 = 100)
6. **Labor productivity** (measured as the average value added per labor hour in each European country, indexed to each year's Eurozone average = 100)
7. **Price level** (measured according to the consumer price index in each European country, divided by the real effective exchange rate)
8. **Inflation rate** (percent change in the consumer price index by country)

The table below shows the results of the factor analysis. Factors 1 through 8 are possible underlying factors that explain the variance across the eight variables used. Each factor has an Eigenvalue, under the column labeled "Variance," which represents the amount of variance that factor explains in the original dataset. Factors 5 through 8 have negative Eigenvalues, so they are dropped. Factors 1 through 4 are kept. Then, the factor matrix is rotated, which means each factor has a better fit on the data. Table One shows the Eigenvalues after rotation, for the four factors that were kept. Factors 1 through 3 have significantly higher Eigenvalues than Factor 4. The commonly used Kaiser criterion states that a factor should be considered explanatory and kept in the analysis if it has an Eigenvalue greater than 1.[80] Factors 1 through 3 have Eigenvalues greater than 1, so they will be the focus of the analysis. The column labeled "Proportion" shows the proportion of total variance in the dataset that each factor explains. The column labeled "Cumulative" suggests that Factors 1 through 3 explain essentially all the variance in the dataset.

Table 1: Factor analysis at national level, 2015

[80]http://www.surveyanalysis.org/wiki/Determining_the_Number_of_Components_in_Principal_Components_Analysis

Factor	Variance	Difference	Proportion	Cumulative
Factor1	2.33692	0.42495	0.4102	0.4102
Factor2	1.91197	0.28580	0.3356	0.7458
Factor3	1.62617	1.41183	0.2854	1.0312
Factor4	0.21434	.	0.0376	1.0688

LR test: independent vs. saturated: chi2(28) = 133.12 Prob>chi2 = 0.0000

Table 2: Factor loadings for national level, 2015

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
nom_eer_2015	-0.0873	0.9033	-0.0111	-0.0536	0.1734
real_ee~2015	0.0910	0.8426	0.2262	0.0693	0.2258
exports~2014	0.4084	-0.4987	0.3398	-0.2681	0.3972
ir_bond~2015	-0.3923	-0.0472	-0.7728	0.0423	0.2448
labourc~2015	-0.4292	0.2547	0.7333	-0.0163	0.2130
relativ~2015	0.8872	-0.1957	0.1583	-0.1348	0.1313
pricele~2015	0.9395	0.1207	-0.0186	0.1228	0.0873
inflati~2015	0.3825	-0.1316	0.5469	0.3154	0.4378

Factor analysis also calculates the factor loadings, which show which variables are correlated with each factor. Table 2 shows the factor loadings and the interpretation for each factor. The variables are ordered in the same order as the variable name list in the previous page. Their abbreviations correspond to the variable names listed above. Factor 1 is highly correlated with the relative labor productivity and the price level. It is also correlated to a lesser extent with the inflation rate, the ratio of exports to imports, the labor cost index, and the bond yield. Factor 2 is correlated almost entirely with the real effective exchange rate and the nominal effective exchange rate. Factor 3 is correlated with the labor cost index, the inflation rate, and the bond yield. These results must be carefully interpreted, because they encompass a relatively small data

set. However, some patterns emerge in the three groups of variables. Factor One seems to be a measure of productivity, which includes the relative productivity itself along with the price level. Factor Two measures the effective exchange rate. Factor Three measures inflation, labor costs, and bond yields. This factor is harder to interpret, but there might be correlation between interest rates as reflected in bond yields, and the inflation rate. Labor costs may also play a part in moving inflation rates. The results of the factor analysis do not confirm causation, so it is important to compare different results. The second analysis with 2005 data and regional data will help to interpret the results.

One of the major potential inaccuracies in this analysis is its inability to account for time effects. The data for all of these economic indicators exists as time series, showing the values of each indicator over a period of about twenty years. Many economic factors could experience endogenous changes, such as an increase in price level due to momentum from the previous year's price level. Factor analysis can only show results for one year at a time and therefore misses these effects. Most importantly, the results from one year could simply be different from another year. If running a factor analysis on data from 2015 produces a different set of factors from an analysis of 2005 data, then there is a major problem with the usefulness of results from any given year.

As discussed previously, this essay will use a very basic way to check the problem. The same analysis will be repeated for data from 2005, and the results will be compared to the baseline results from the 2015 data. If the results are relatively similar, then it will be assumed that there has not been significant change in the time period covered by this paper. This basic workaround seems reasonable because the theory of optimal currency areas suggests that the factors that determine the functioning of an OCA should be stable over time. According to OCA

theory, the determining factors of a currency area's optimality are structural factors such as patterns of production, capital and labor markets, and production costs. There is no implication that over time, a different factor will come to be important for the optimal functioning of a currency area.

While it would be even more informative to include endogenous effects and a deeper analysis of the time series implications of this factor analysis, the basic test comparing two different years suggests that the results are fairly similar over time. The following table shows the results from a factor analysis using the same variables, but using data from 2005:

Table 3: Factor analysis at national level, 2005

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Factor	Variance	Difference	Proportion	Cumulative
Factor1	2.00633	0.15610	0.2881	0.2881
Factor2	1.85023	0.03935	0.2657	0.5537
Factor3	1.81088	0.41720	0.2600	0.8137
Factor4	1.39368	1.33027	0.2001	1.0138
Factor5	0.06341	.	0.0091	1.0229

LR test: independent vs. saturated: chi2(28) = 211.42 Prob>chi2 = 0.0000

Table 4: Factor loadings for national level, 2005

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Uniqueness
nom_eer_2005	0.9478	-0.1744	-0.0525	-0.1404	0.0281	0.0481
real_ee~2005	0.8674	0.3882	0.2130	0.1285	-0.0004	0.0351
exports~2005	-0.0220	0.2431	0.8822	0.1351	-0.0404	0.1422
ir_bond~2005	0.3191	-0.3029	-0.2153	-0.7424	0.0617	0.2051
labourc~2005	0.1609	0.7811	0.2180	0.3974	0.1548	0.1346
relativ~2005	0.2115	0.2833	0.6625	0.6002	0.1220	0.0609
pricele~2005	0.4252	0.4183	0.5631	0.4936	0.0455	0.0813
inflati~2005	0.0452	-0.8080	-0.3666	-0.1620	0.1275	0.1682

Table 3 shows the results for the analysis with 2005 data, after rotation. There is one important difference from the 2015 analysis: there are now four factors with Eigenvalues greater than 1. Therefore Factors 1 through 4 are considered relevant, and it is important to interpret them. Table 4 shows the factor loadings and suggests that the factors are not significantly different from the 2015 factors, just in a different order of significance. Factor One includes the nominal effective exchange rate and the real effective exchange rate. This factor is essentially the same as Factor Two in the 2015 analysis, but in the results from 2005 it has a greater Eigenvalue. This suggests that the exchange rate factor was more impactful in explaining the variance in 2005 than in 2015. Factor Two includes the labor cost index and the inflation rate. There are also lesser correlations with the real effective exchange rate, the bond yield, and the price level. This factor seems to be similar to Factor Three in the 2015 analysis, which included the labor cost and inflation rates. There are two important differences, because the correlation coefficient for the inflation rate seems to be negative in 2005, and bond yield has a much lower correlation coefficient. It is more difficult to explain this factor, and to explain the negative correlation with inflation. The negative correlation could be showing the effect of an interest rate hike which decreased the inflation rate, but this is only a hypothetical explanation. This factor does still

resemble Factor Three from the 2015 analysis, but it becomes significantly less clear. Factor Three includes the ratio of exports to imports, the relative labor productivity, the price level, and with a smaller coefficient the inflation rate. This factor is very similar to Factor One from the 2015 analysis, which reflected the labor productivity. The ratio of exports to imports now has a larger coefficient, but it was already present in the 2015 data.

The composition of Factors 1 through 3 remains fairly similar to their composition in 2015. The factors simply have a different order, because they each explain different proportions of the total variance as reflected by their different Eigenvalues in 2005. The only significant difference from the 2015 results is the presence of a fourth seemingly significant factor, which accounts for roughly 20% of variance in the data. Factor Four has the highest correlation with the long term bond yield. The next strongest correlations are the relative labor productivity, the price level, and the labor cost index. Therefore it is very difficult to interpret this factor. It does not seem like this fourth factor represents any important missing factor from the 2015 data. It cannot be dismissed, because it has a significant Eigenvalue, but it could also be a random outlier. The results from 2005 are similar enough to the 2015 results that major changes over the time period of this essay would not seem to be a major concern. The important patterns in the data remain the same.

The last important adjustment to the analysis is the inclusion of a larger data set. The national data only comprises 27 observations, or fewer in cases where there is data missing for some countries. This limited data set calls into question the accuracy of the results. Therefore, it is possible to use regional data to get more observations and a more accurate estimate. This second version of the analysis uses observations from 239 regions within the EU. With this larger data set, it is possible to approach the threshold of 300 observations that the UCLA IDRE

considers sufficient. Because it is more accurate to estimate correlations between two variables with a large number of observations, the results of the factor analysis will be more robust. The regional data also includes some new indicators that can be added as extra variables. There are four additional variables in this regional analysis that were not included in the previous two. The factors can be estimated more robustly with the new variables, because they help to isolate the effects of other variables. Three of the four added variables are indicators of business geography, or patterns of production, within regions. These variables show the percentage of the region's labor force employed in knowledge-intensive services, high-tech manufacturing, and general manufacturing.

Optimal currency area theory suggests that patterns of production within different regions are very important to the functioning of a currency area. A region that relies on low skill manufacturing will likely need a different monetary policy than a region specializing in high-wage knowledge-intensive services. It would be expected that a region that specializes in knowledge intensive services, such as financial services, would have high wage and price levels. However, such a region might be less affected by interest rate changes than a region specializing in manufacturing, because it has smaller investment needs. These types of differences between regions represent the types of divergences that optimal currency area theory considers suboptimal for the functioning of a currency area. Regions with different patterns of production are more likely to suffer asymmetric shocks of the type described by Mundell and then explored by Eichengreen and Bayoumi.

The fourth new variable, gross fixed capital formation, measures investment in productive assets within each region. This GFCF variable is another indicator of patterns of

economic activity in different regions, because regions with a larger investment rate are likely to have a different pattern of production from those with lower rates.

The eight original variables were assumed to be standard across every region of their respective country. For each region, the four new variables have unique values. The regional values of the eight original variables were assumed to be the same as the national value (for example, the inflation rate for every region of Belgium is the same as the national inflation rate for Belgium). The new set of variables is:

1. **Percentage** of the regional population **employed in high-tech manufacturing**
2. **Percentage** of the regional population **employed in knowledge intensive services** (KIP)
3. **Percentage** of the regional population **employed in any manufacturing**
4. **Gross fixed capital formation** (the total investment by producers in fixed assets by region by year, measure of investment)
5. **Nominal effective exchange rate** (measured as an index for each European country where the value for 2011=100, not deflated)
6. **Real effective exchange rate** (measured as an index, where the exchange rate value of the Euro in each European country in 2011 = 100, deflated by the consumer price index of each country)
7. **Ratio of total exports over total imports** (calculated at the national level and standardized across regions)
8. **Long term bond yield** (measured according to the Maastricht convergence criteria, based on the long term yield of government bonds for each European country)
9. **Labor cost** (measured as the average of total compensation per worker, measured as index for each European country in 2011 = 100)
10. **Labor productivity** (measured as the average value added per labor hour in each European country, index where 2011 value = 100)
11. **Price level** (calculated as a ratio of purchasing power parities to exchange rates – only available at the national level and standardized across regions)
12. **Inflation rate** (percent change in the consumer price index by country)

The results of the new analysis with additional variables are as follows:

Table 5: Factor analysis at regional level, 2015

Factor	Variance	Difference	Proportion	Cumulative
Factor1	2.94494	0.36732	0.3376	0.3376
Factor2	2.57762	1.32523	0.2955	0.6332
Factor3	1.25239	0.00760	0.1436	0.7768
Factor4	1.24480	0.34167	0.1427	0.9195
Factor5	0.90312	0.76781	0.1035	1.0230
Factor6	0.13531	0.08613	0.0155	1.0385
Factor7	0.04918	.	0.0056	1.0442

LR test: independent vs. saturated: chi2(66) = 2492.00 Prob>chi2 = 0.0000

Table 6: Factor loadings for regional level, 2015

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7	Uniqueness
per_hit~2015	0.1581	0.0997	0.1088	0.2232	0.7144	0.0269	0.0180	0.3919
per_kis_2015	0.4778	0.3019	-0.1371	0.6702	0.3491	0.0444	-0.0365	0.0875
per_man~2015	-0.0809	-0.3128	0.2757	-0.7049	-0.0492	0.0300	-0.0200	0.3189
gfcf_2015	0.2353	-0.0564	-0.1034	0.0618	0.4733	-0.1140	-0.0438	0.6880
nom_eer_2015	-0.0549	0.9656	-0.0272	0.1400	0.0261	-0.0862	0.0063	0.0362
real_ee~2015	0.0699	0.9495	0.0959	0.1026	0.0477	0.0888	-0.0031	0.0637
exports~2014	0.3634	-0.5228	0.1041	-0.2809	0.0869	-0.0465	0.2012	0.4547
ir_bond~2015	-0.8061	0.0576	-0.4155	0.0300	-0.1306	0.0032	0.0338	0.1551
labourc~2015	-0.1023	0.0784	0.8358	-0.1979	0.0387	0.0085	0.0086	0.2440
relativ~2015	0.8709	-0.0903	-0.3051	0.1691	0.0811	-0.1227	0.0560	0.0869
pricele~2015	0.7073	0.4962	-0.3844	0.2450	0.0735	-0.0210	0.0002	0.0398
inflati~2015	0.7554	-0.0672	0.0464	0.0860	0.0583	0.2927	-0.0184	0.3259

The results show that Factors 1 through 4 have Eigenvalues greater than 1.0, and Factor 5 has a very close value of 0.9. These factors together account for essentially all of the variance within the data set. The cumulative value shown is actually slightly over 100%, due to calculation inaccuracies. It is possible the new factor may represent some of the new variables, which would mean that the variables included in the new factor were not correlated with any of

the variables in the previous three factors. However, the initial list of factors is not fully informative and the factor loadings will give a better picture of the results.

The factor loadings are generally similar to the first two analyses, but there are some differences in variable correlations. The first two factors remain largely similar to the factors from the original analysis, and remain the most important factors of the set. Factor One is correlated with the price level and relative labor productivity by country. In this version of the analysis it is also strongly correlated with the inflation rate, which in previous analyses was more correlated with labor costs. Factor One is also correlated with the bond yield, which has been associated with different factors in every analysis. It is also somewhat correlated with the new variable for employment in knowledge intensive services. This correlation has interesting implications, because it could mean that regions specializing in knowledge intensive services have higher relative productivity and price levels. Factor Two, as in the original analysis, is almost completely correlated with the real and nominal effective exchange rates. There are also smaller correlations with the ratio of exports to imports and the price level variable. This result confirms the relevance of the exchange rate factor in the original analysis. Factor Three is mostly correlated with the labor cost index. It is also correlated with employment in manufacturing, the price level, and bond yield, although much more weakly. These three factors are very similar to the results of the original analysis, although the most important change is that inflation is associated with labor productivity instead of labor cost. The employment variables add some potential implications to the results because of the correlation between employment in knowledge intensive services and productivity.

Factor Four is different from the previous analyses and reflects the new variables included. This factor is mostly correlated with the variable for employment in knowledge

intensive services, and negatively with the variable for employment in manufacturing. There are also much smaller correlations with the ratio of exports to imports, and with the price level variable. This result seems to support the hypothesis that production patterns in regions are important factors in structural divergences from an optimal currency area. The level of employment in knowledge intensive services determines a significant portion of the variability across all the indicators studied. Factor Five has a smaller Eigenvalue, but it is very close to the threshold for significance. Factor Five is most closely correlated with the variable for employment in high tech manufacturing. It is also correlated with employment in knowledge intensive services, and with the variable for gross fixed capital formation. This factor is similar to Factor Four, but it clearly reflects the presence of high-tech capital-intensive manufacturing in a region. This result suggests that regions specializing in industries that are capital and investment intensive experience significant divergences from other regions. The regional analysis confirms the basic robustness of the first three factors: price level and labor productivity, effective exchange rates, and labor costs. However, the new variables underscore the significance of different regional patterns of production. Differences in employment in key industries such as knowledge intensive services explain a significant part of the variability across many indicators of monetary divergence.

All the iterations of the factor analysis confirm some basic results with two or three particularly important factors. It is important to remember that the results of factor analysis do not imply any causal relationship between the components of a factor, or between a factor and its component. The results do provide valuable insight into the correlations between different variables of the data. However, the results as shown above are different enough that it is not possible to confirm a single set of factors as the ideal indicator for convergence towards an

optimal monetary area. Although factor analysis is sometimes used to generate an index based on its results, this essay will not create an index of convergence due to the varied results in some of the factors. Instead this section will review the factor results across all three analyses and identify the most stable or informative to use as individual indicators. The most stable factor across all three analyses is the effective exchange rate factor. This factor had high correlations with the real effective exchange rate and the nominal effective exchange rate. It did not have high correlation with any other variable. Given the long history of exchange rates in the European debates about monetary union and their effects on a country's competitiveness, the real effective exchange rate is one useful indicator of convergence. The factor which represents the relative labor productivity, price level, and in some versions inflation and bond yields, also remains relatively stable. There are differences across the three analyses in the composition of this factor and the amount of variance it explains, but it is always significant. The best measure for this factor may be relative labor productivity, because that indicator is indexed to the Eurozone average. It is therefore a useful way to compare productivity across members of the currency area.

The results for the labor cost index and the inflation rate are more difficult to interpret. The labor cost index and inflation rate are both correlated to the same factor in the national analyses for 2005 and 2015. However, in the regional analysis inflation has almost no correlation with the labor cost, and instead seems to be more highly correlated with labor productivity (Table 6). In the national 2005 data, inflation also has a negative correlation with the corresponding factor while labor costs have a positive correlation. As discussed in the analysis results, this discrepancy could potentially be explained by a lag in the business cycle that affected one indicator but not the other. In any case, it does not seem possible to account for both inflation and labor costs in a single factor. Neither one of these indicators can be assigned to a

different factor based on the results. However, inflation is an important indicator that was used in the Maastricht convergence criteria. It reflects both the business cycle of an economy and structural conditions like the labor cost (even if there is an erratic correlation in these analyses). Therefore inflation rate will be considered an indicator of convergence even if it does not fit easily with the factor analysis.

Finally, the indicators for economic geography are very relevant in the regional analysis. The variable for employment in knowledge intensive services has some level of correlation with many factors, and it is highly correlated with one unique factor. That factor is also negatively correlated with employment in manufacturing, although not with employment in high tech manufacturing. Therefore this factor seems to represent the pattern of production in a given region. Regions that specialize in knowledge intensive services will be very different from those that specialize in basic manufacturing. This factor will be represented by the percent of the total population employed in knowledge intensive services.

The factor analysis narrowed down the list of indicators of convergence. All of these indicators are important because as the factor analysis showed, they are correlated with other relevant economic variables. These indicators are consistent with the conclusions of optimal currency area theory. They are different from the Maastricht convergence criteria, which will be discussed at the end of this section. The factor analysis does not suggest any causal relationship between these indicators and convergence, or between the indicators themselves. However, the analysis suggests that the following indicators show valuable insights about whether different economies are similar enough to be in an optimal currency area:

1. Real effective exchange rate
2. Relative labor productivity

3. Inflation rate
4. Employment in knowledge intensive services

3.4: Poland as a case study for convergence indicators

While the factor analysis served to narrow down some of the most important indicators of convergence towards an optimal monetary area, they could have many different uses. In this section, one specific example will be considered by analyzing the divergences between Poland and the Eurozone average. Poland is an interesting case study because it is near one of the core areas of the Eurozone, Germany, but it is not in the Eurozone itself. It is an example of a country which is presumably integrated with the European economy and may join the monetary union in the future, but there are enough divergences to keep it out at the moment. The case study of Poland will illustrate one possible use for the three main indicators identified in the factor analysis. The price level, exchange rate, and labor cost indicators could be used to give a simple overview of the most important factors of divergence between a national economy like Poland's and the Eurozone average. This simple analysis will use the same Eurostat dataset used for the factor analysis.

The following tables show the price level and productivity, real effective exchange rate, and labor cost index for Poland compared to the Eurozone average:

Table 7: Inflation Rate

HICP Rate	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Eurozone Average		1.6	1.1	1.1	2.1	2.3	2.2	2.1	2.1	2.2	2.2
Poland		15.0	11.8	7.2	10.1	5.3	1.9	0.7	3.6	2.2	1.3

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
2.1	3.3	0.3	1.6	2.7	2.5	1.4	0.4	0.0	0.2	1.5
2.6	4.2	4.0	2.6	3.9	3.7	0.8	0.1	-0.7	-0.2	1.6

Table 8: Nominal Relative Labor Productivity

Nominal F	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Eurozone	123.4	122.8	123.0	122.2	120.9	118.4	117.6	116.3	115.2	115.4	115.3
Poland					44.7	45.4	47.3	48.3	49.7	49.4	48.7

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
114.9	114.2	114.0	112.7	112.5	112.2	112.6	112.3	111.6	111.7	:
49.6	50.3	52.7	56.6	58.9	59.6	59.3	58.9	58.9	59.1	:

Table 9: Real Effective Exchange Rate

Real Effec	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Eurozone	108.06	98.15	100.01	98.04	87.92	89.23	92.27	102.77	105.68	102.72	101.82
Poland	76.70	78.41	85.58	84.27	92.46	103.44	98.84	88.11	87.11	96.84	98.24

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
103.92	106.97	109.37	100.00	99.64	94.73	98.06	98.65	91.18	93.49	94.58
101.32	110.26	94.24	100.00	97.65	95.53	95.73	96.69	94.29	90.96	93.06

Table 10: Percent of population employed in knowledge intensive services

%KIS	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Eurozone	:	:	:	:	29.7	30.3	30.6	31.3	32.1	32.4	32.7
Poland	:	:	:	:	:	:	:	:	24.3	24.5	24.7

2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
32.9	37.3	38.3	38.9	39.2	39.5	39.5	39.9	40.0	40.1
24.8	28.3	29.5	30.1	30.0	30.6	31.2	31.4	31.2	30.9

The four indicators show important divergences between Poland and the Eurozone. Each of the tables must be interpreted independently, because each indicator is measured in different ways. Table 1 shows the evolution of Poland's inflation rate compared with that of the Eurozone.

The difference between the Polish and EZ inflation rates is initially very large, but it decreased sharply around 2001. After 2002 the Polish inflation rate remains similar to that of the EZ but consistently higher until 2013. After 2013, Poland has had a slightly lower inflation rate than the Eurozone average. The factor analysis suggested that the inflation indicator is correlated with labor costs. It is not possible to affirm that labor costs in Poland follow the same pattern as inflation, but the inflation data suggests that labor costs should not have very large divergences.

Table 2 shows Poland's labor productivity per hour worked, as a percentage of the EU28 average. This indicator shows a significant and consistent difference between Poland and the Eurozone average. From 1996 until 2017, Poland's labor productivity is about 50% lower than the Eurozone average. There has been a slow convergence, although it seems to have stalled since 2012. The productivity indicator is also correlated with indicators for price level and export-import ratio, according to the factor analysis. Therefore, the productivity indicator shows a significant divergence between the less productive Polish economy and the more productive Eurozone.

Table 3 shows the changes in Poland's real effective exchange rate compared to the Eurozone average. It is not possible to directly compare these exchange rates to each other, because they are both indexed according to their respective values in 2010. However, the indicator reveals valuable information about the movement of effective exchange rates. The data shows considerable fluctuations in Poland's real effective exchange rate before 2010. These fluctuations were also not symmetric with the Eurozone's exchange rate fluctuations, because Poland's exchange rate appreciated until 2001 while Europe's depreciated, and then depreciated while Europe's exchange rate appreciated. This data suggests that Poland's economy was not synchronized with the Eurozone's economy in important areas. However, after 2010 the

fluctuations became smaller. Although Poland's exchange rate still didn't move in the same direction as the Eurozone's, the movements were smaller. This change may suggest that some convergence is taking place between effective exchange rates.

Finally, Table 4 shows the percentage of the population employed in knowledge intensive services for Poland and the Eurozone. The data started to be collected later than the other indicators, so it is only possible to compare values after 2004. Since 2004 there has been a consistent difference, with the Eurozone employing 10% more of its population in knowledge intensive services than Poland. The difference does not seem excessive, but it is significant. This result suggests that Poland and the Eurozone have differences in their pattern of production as illustrated by employment in knowledge intensive services.

While the data from these four indicators must be interpreted carefully, it offers insights into some of Poland's divergences from the Eurozone. Poland's inflation rate has clearly drawn closer to that of the Eurozone in the past five years. This change may point towards some convergence. The variables correlated with inflation rate, such as labor costs, may also be relatively convergent. Poland's labor productivity remains significantly lower than that of the Eurozone. This indicator is especially significant because it is also correlated with price level and export fluctuations, and may suggest that these variables are also divergent. Poland's effective exchange rate has shown asynchronous fluctuations, but the magnitude of those fluctuations is decreasing. This shift may suggest a gradual convergence with the Eurozone. Poland's economic geography is fairly different from the Eurozone, with less of its total population employed in knowledge intensive services. Whether these indicators meet the threshold for Poland to be in an optimal currency area with the Eurozone is outside the scope of this paper. Poland meets many of the Maastricht criteria, but it has not initiated the final process to join the Eurozone. However,

the indicators reveal significant divergences remaining between Poland's labor productivity relative to the Eurozone at large.

3.5: Indicators of convergence and the Maastricht criteria

The results of the factor analysis illustrate some of the most important possible indicators of convergence towards an optimal currency area. The data suggests that indicators of productivity and price level, effective exchange rates, and inflation and labor costs are the most relevant indicators of convergence. Indicators of economic geography such as percent employment in knowledge intensive services and manufacturing also offer important insights about converge.

These results fit comfortably with the theory of optimal currency areas, but give a more precise notion of the conditions for an OCA. The overview of OCA theory suggested that when a currency area lacks strong adjustment mechanisms for a shock, its members should have similar business cycles and patterns of production. The set of indicators obtained from the factor analysis captures both of these conditions. Inflation generally reflects the business cycle, and the different employment variables also capture fluctuations in the business cycle. To the extent that the indicators capture the business cycle, they also reflect the empirical work on the significance of asymmetric shocks. If the indicators for inflation and employment show a relatively synchronized business cycle between parts of a currency area, they indicate a lack of asymmetric shocks. The employment variables reflect regional patterns of production in key sectors such as knowledge intensive services and manufacturing. The indicator for labor productivity is closely related with regional patterns of production, because productivity plays a large role in forming specialization patterns in regions.

The results of the factor analysis differ from the Maastricht criteria. These criteria are still used to measure a country's suitability to join the Eurozone. They include the HICP inflation rate, budget deficit, debt ratio, bond yield, and a requirement of exchange rate stability for two years.[81] The budget deficit and debt ratio are included to avoid irresponsible fiscal policies by potential members, but they are not relevant in the context of optimal currency area theory. Therefore they were not included in the factor analysis. The requirement for exchange rate stability states that potential candidates must successfully keep their currency pegged to the Euro for two years. However, it does not measure whether the real exchange rate of the potential candidate is actually convergent with the rest of the Eurozone. The factor analysis suggests that the real effective exchange rate is a very important factor of convergence, but it is not included in the Maastricht criteria. The bond yield was included in the factor analysis, but the results were inconclusive about its importance as a factor. It may be a relevant indicator, but the results suggest that it is not as important as other factors like the effective exchange rate. The inflation rate was also included in the factor analysis, and it seems to be significant. Although the results of the factor analysis are difficult to interpret because the correlation coefficients for inflation were different across different versions of the analyses, it was still significant in all of them. However, the results of the factor analyses suggest that the Maastricht criteria are not the best indicators of convergence towards an optimal currency area. The Maastricht criteria fail to capture some important factors of convergence, which may be one reason behind the imbalances of the Eurozone in recent years.

[81] https://ec.europa.eu/info/business-economy-euro/euro-area/enlargement-euro-area/convergence-criteria-joining_en

At the same time, the results of the factor analysis are not conclusive evidence that the indicators used in this essay are the best or only indicators of convergence towards an optimal currency area. They seem to be useful illustrations of some important factors to consider and raise interesting implications. One interesting result is the importance of patterns of production when considering convergence between regions. The regional factor analysis shows the correlation between employment in knowledge intensive services and important indicators of convergence like effective exchange rates and price levels/inflation. The results of the regional factor analysis suggest that in order to evaluate whether members of a currency area have optimal conditions, it is necessary to examine their patterns of production alongside nominal indicators. In the absence of adjustment mechanisms like fiscal unity, an optimal currency area may require regions with similar patterns of production that have similar monetary policy needs. Even when some nominal indicators show convergence, a sudden shock can reveal underlying divergences and imbalances.

The case study of Poland shows how the indicators measure convergence towards an optimal currency area. The indicators suggest that Poland is partially but not fully convergent with the Eurozone. Poland's inflation rate has been moving at relatively similar levels to the Eurozone average for the past five years. However, Poland's labor productivity is still significantly lower than the Eurozone average and may pose obstacles to an optimal monetary policy. Its real effective exchange rate is not moving very differently from the Eurozone, but it is not moving in sync with the Eurozone. These indicators are not to be taken as conclusive proof of convergence or divergence, but they reveal potential issues with including Poland in the Eurozone.

Conclusion

The European Union's history and policies make for a fascinating area of economic study because it is not an optimal currency area. Applying the optimal currency area framework to the EU forces one to evaluate what defines an integrated economic structure. There are valuable insights to be found in the broad analytical conclusions of OCA theory, the history and documents of the EU's creation, and the attempt to measure the divergences from OCA empirically. The history of the EU from its origins in the post-war period to the recent crisis makes it clear that OCA theory did influence its structure, but it was not the primary concern when creating the economic and monetary union.

For that reason, there are a number of gaps between optimal currency area theory and the current reality of the EU. Identifying and addressing these gaps is essential to the performance of the union. Since the EU lacks the flexible adjustment mechanisms that made the US into a successful currency area, it is more vulnerable to asymmetric shocks and imbalances arising from the divergence between its members. In the absence of robust adjustment mechanisms such as a fiscal union, the most important requirement for the EU to function optimally is a high degree of similarity between its member parts. The members of an optimal currency area should have synchronized business cycles and similar patterns of cost and production.

These requirements are difficult to measure due to the number of different indicators that could be used, but the factor analysis shows that they can be narrowed down to three or four key variables. The results of the factor analysis suggest that effective exchange rates, labor productivity, inflation rate, and employment in knowledge intensive services can explain a large portion of the total variance across all the indicator variables. While there are still many open questions about the best way to interpret these results and their causal value, the case study of

Poland illustrates their usefulness for a brief overview of convergence towards an optimal currency area.

The European Union has surprised many by enduring severe crises in recent years. Its resilience shows the underlying strength of its political and economic institutions. To some extent, these institutions were influenced by decades of work on the conditions for an optimal currency area. However, the lack of adjustment mechanisms and the divergences in business cycle and production patterns have posed major challenges for the EU. A factor analysis of different indicators of convergence towards an optimal currency area suggests that the Maastricht criteria are not the best indicators for a country's suitability to enter the Eurozone. The Maastricht criteria miss important information about real effective exchange rates, labor productivity, and patterns of production. Achieving a greater degree of convergence in these indicators may be the only way for the Eurozone to become a more optimal currency area. For the time being, the jury is still out on the ambitious and fascinating economic project of the European Union.

Appendix A: Expanded methodology

Factor analysis is a multivariable model that is useful to explore the relationships between a large number of different outcome variables and reduce their number. The general principle behind factor analysis is that a given number of observable variables reflect an equal or smaller number of unobservable factors that move several of the observable variables.[82] Factor analysis is used commonly with datasets containing many different variables in order to reduce their number, and sometimes to create a new index out of a combination of variables. This paper will not attempt to define an index through factor analysis, because the method has limitations that mean the results must be interpreted carefully. While there are some clear relationships between the variables that indicate an optimal currency area, the results are not robust enough to support an index that conclusively indicates convergence of divergence from an optimal currency area. However, factor analysis is very useful for grouping some variables together if they are affected by common latent factors. Factor analysis has been used for this purpose in economic for some time. For the past few decades there has been work using factor analysis to find relationships between indicators of the business cycle.[83] This work illustrates the utility of factor analysis to estimate economic concepts that are difficult to define. As Diebold and Rudebusch point out, the business cycle can be expressed through many different indicators, and does not have a single clear definition. Factor analysis has been used to identify latent factors that move many of the observable variables simultaneously.

The technique of factor analysis relies on summarizing the correlation structure of the variables used.[84] Correlated variables in the data set are assumed to have a linear relationship

[82] York University, Ch. 14
[83] Diebold and Rudebusch (1994)
[84] Garrett-Mayer (2006)

with underlying latent common factors. Each factor explains a portion of the total variance in the data set, and the sum of the factors explains all of the variance in the original data set. However, some factors normally explain a significantly larger portion of the variance, so the analysis focuses on the most explanatory factors. By keeping a smaller number of factors than the original number of variables, factor analysis can be used to reduce the number of observable variables into fewer variables or indices that capture the movement in several of the observable variables.[85] Additionally, factor analysis outputs a matrix of factor loadings, showing how much correlation there is between each variable and each factor. Therefore, it is possible to identify with which variables each factor is most closely related.

The main drawbacks to factor analysis in the context of monetary union are that it is only possible to analyze a cross section of the data, and the small number of observations. Factor analysis is designed to take a cross section of data and describe a static relationship at a given moment in time. However, the data describing the monetary characteristics of the European economic and monetary union is naturally a time series which shows their change over time. Using a cross section of data from any given year might be problematic because a factor analysis of data from 2005 will generate factors based on the relationships between variables as they were in 2005. There is an extensive literature in econometrics that developed a dynamic factor analysis model, as described by Stock and Watson.[86] Dynamic factor analysis has also been used by Bernanke et al., and Diebold and Rudebusch.[87] This analysis replaces the cross section variables in classic factor analysis with time series variables. However, this paper's analysis is cross sectional by nature, because it is accounting for differences between European countries.

[85] UCLA IDRE
[86] Stock and Watson (2010)
[87] Bernanke et al. (2004)

Therefore, a dynamic factor analysis model is not the best fit for this analysis. Instead, the results will contain a classic factor analysis for two different years. We will verify whether the results are significantly different for two years, one near the beginning of the available data and one in the present. We will confirm whether the results are significantly different for two observed years about twenty years apart. Based on optimal currency area theory, the general conditions that need to hold for an OCA such as synchronized business cycles and symmetric shocks would seem to be fairly stable over time. Therefore checking the results for two different years only serves as a basic check of this principle that the fundamental requirements for an OCA are not time sensitive. Nevertheless, a faction of European policymakers believed that conditions for an OCA could develop over time based on the endogenous process of integration. A deeper analysis of the time implications for OCA is needed but is outside the scope of this essay. The other major obstacle when employing factor analysis is the small number of observations per variable. The UCLA Institute for Digital Research and Education cites studies that propose a "good" number of observations per variable to be around 300.[88] Given smaller numbers, the correlation between different variables becomes less reliable. The data used in this essay comes at two different levels: national and regional. The national data is available for the 28 countries of the European Union. This analysis will use data for those 28 countries, and not the 19 countries of the Eurozone. The EU members which are not in the Eurozone are still closely integrated with the EZ members. In the case of Eastern European countries, the EU expects to eventually include those economies in the currency area. These countries will be included in the analysis even if they are not part of the currency area because the factor analysis only measures the correlation structure of indicator variables. It is not intended to measure whether the 19 Eurozone countries,

[88] UCLA IDRE

or the 28 European Union members are actually an optimal currency area or not. Although there may be some elements of being in a single currency area that affect the movement of the variables for the cases of the Euro 19, it is assumed that the effect will not be large because for variables such as interest rates, countries outside the Eurozone have experienced similar economic conditions to those inside it. The second type of data used in this essay is regional data, which is available for the NUTSII classification of subnational regions within European countries. There are 1,311 NUTSII regions identified, a much more optimal number to conduct a factor analysis with. However, many variables are only available at the national level. Some variables, like real exchange rates and interest rates, are unified within national economies. For other variables, regional data is not collected. Therefore, while it would be optimal to have data at the regional level for all variables included in the analysis, the data is not available. One iteration of the analysis will be conducted using only national data, and then another will be conducted with national and regional data.

Appendix B: Data sets, Stata code, and full tables

Eurostat data sets with ID codes:

Employment in technology and knowledge-intensive sectors by NUTS 2 regions and sex (from 2008 onwards, NACE Rev. 2) (htec_emp_reg2)

Employment in technology and knowledge-intensive sectors by NUTS 2 regions and sex (1994-2008, NACE Rev. 1.1) (htec_emp_reg)

Export to import ratio (egi_tr1)

Gross fixed capital formation by NUTS 2 regions (nama_10r_2gfcf)

Labour cost index by NACE Rev. 2 activity - nominal value, annual data (lc_lci_r2_a)

Industrial countries' effective exchange rates - annual data (ert_eff_ic_a)

EMU convergence criterion series - annual data (irt_lt_mcby_a)

Labour productivity and unit labour costs (nama_10_lp_ulc)

HICP (2015 = 100) - annual data (average index and rate of change) (prc_hicp_aind)

Purchasing power parities (PPPs), price level indices and real expenditures for ESA 2010 aggregates (prc_ppp_ind)

Stata .do file:

```
import excel "National Analysis Final.xlsx", firstrow
factor nom_eer_2015 real_eer_2015 exports_imports_2014 ir_bondyield_2015
labourcost_index_2015 relative_labourprod_2015 pricelevel_2015 inflation_2015
rotate
factor nom_eer_2005 real_eer_2005 exports_imports_2005 ir_bondyield_2005
labourcost_index_2005 relative_labourprod_2005 pricelevel_2005 inflation_2005
rotate
clear
import excel "Regional Analysis Final.xlsx", firstrow
factor per_hitech_2015 per_kis_2015 per_manu_2015 gfcf_2015 nom_eer_2015 real_eer_2015
exports_imports_2014 ir_bondyield_2015 labourcost_index_2015 relative_labourprod_2015
pricelevel_2015 inflation_2015
```

rotate

Stata output:

```
Factor analysis/correlation                      Number of obs    =         27
    Method: principal factors                    Retained factors =          4
    Rotation: (unrotated)                        Number of params =         26
```

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	2.70819	0.76749	0.4753	0.4753
Factor2	1.94070	0.70263	0.3406	0.8160
Factor3	1.23807	1.03563	0.2173	1.0333
Factor4	0.20244	0.25893	0.0355	1.0688
Factor5	-0.05649	0.02297	-0.0099	1.0589
Factor6	-0.07946	0.02810	-0.0139	1.0449
Factor7	-0.10756	0.04095	-0.0189	1.0261
Factor8	-0.14851	.	-0.0261	1.0000

```
    LR test: independent vs. saturated:  chi2(28) =  133.12 Prob>chi2 = 0.0000
```

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
nom_eer_2015	-0.4279	0.7082	0.3545	0.1275	0.1734
real_ee~2015	-0.1736	0.8281	0.2415	0.0048	0.2258
exports~2014	0.6617	-0.1724	-0.2830	0.2351	0.3972
ir_bond~2015	-0.5781	-0.5281	0.3724	-0.0585	0.2448
labourc~2015	-0.2213	0.5552	-0.6546	0.0347	0.2130
relativ~2015	0.8927	0.0508	0.2257	0.1353	0.1313
pricele~2015	0.7520	0.2342	0.5322	-0.0951	0.0873
inflati~2015	0.5581	0.2813	-0.2695	-0.3145	0.4378

Factor analysis/correlation — Number of obs = 27
Method: principal factors — Retained factors = 4
Rotation: orthogonal varimax (Kaiser off) — Number of params = 26

Factor	Variance	Difference	Proportion	Cumulative
Factor1	2.33692	0.42495	0.4102	0.4102
Factor2	1.91197	0.28580	0.3356	0.7458
Factor3	1.62617	1.41183	0.2854	1.0312
Factor4	0.21434	.	0.0376	1.0688

LR test: independent vs. saturated: chi2(28) = 133.12 Prob>chi2 = 0.0000

Rotated factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Factor4	Uniqueness
nom_eer_2015	-0.0873	0.9033	-0.0111	-0.0536	0.1734
real_ee~2015	0.0910	0.8426	0.2262	0.0693	0.2258
exports~2014	0.4084	-0.4987	0.3398	-0.2681	0.3972
ir_bond~2015	-0.3923	-0.0472	-0.7728	0.0423	0.2448
labourc~2015	-0.4292	0.2547	0.7333	-0.0163	0.2130
relativ~2015	0.8872	-0.1957	0.1583	-0.1348	0.1313
pricele~2015	0.9395	0.1207	-0.0186	0.1228	0.0873
inflati~2015	0.3825	-0.1316	0.5469	0.3154	0.4378

Factor rotation matrix

	Factor1	Factor2	Factor3	Factor4
Factor1	0.8587	-0.3875	0.3350	-0.0145
Factor2	0.1467	0.8095	0.5635	0.0747
Factor3	0.4907	0.4330	-0.7551	0.0403
Factor4	0.0184	0.0838	0.0068	-0.9963

Factor analysis/correlation — Number of obs = 26
Method: principal factors — Retained factors = 5
Rotation: (unrotated) — Number of params = 28

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	4.22311	2.33770	0.6064	0.6064
Factor2	1.88541	1.31715	0.2707	0.8771
Factor3	0.56826	0.16790	0.0816	0.9587
Factor4	0.40036	0.35298	0.0575	1.0161
Factor5	0.04739	0.06914	0.0068	1.0229
Factor6	-0.02175	0.01958	-0.0031	1.0198
Factor7	-0.04133	0.05540	-0.0059	1.0139
Factor8	-0.09673	.	-0.0139	1.0000

LR test: independent vs. saturated: chi2(28) = 211.42 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Uniqueness
nom_eer_2005	0.0392	0.9692	0.0610	-0.0792	-0.0334	0.0481
real_ee~2005	0.6385	0.7306	-0.1437	0.0120	-0.0524	0.0351
exports~2005	0.7213	-0.1641	0.4471	0.3327	-0.0053	0.1422
ir_bond~2005	-0.5858	0.5441	0.0299	0.3776	0.1105	0.2051
labourc~2005	0.8301	-0.0534	-0.3934	-0.0146	0.1359	0.1346
relativ~2005	0.9076	-0.0299	0.2794	-0.1778	0.0696	0.0609
pricele~2005	0.9292	0.1877	0.1039	-0.0958	-0.0055	0.0813
inflati~2005	-0.7577	0.2247	0.3155	-0.3157	0.0892	0.1682

Factor analysis/correlation — Number of obs = 26
Method: principal factors — Retained factors = 5
Rotation: orthogonal varimax (Kaiser off) — Number of params = 28

Factor	Variance	Difference	Proportion	Cumulative
Factor1	2.00633	0.15610	0.2881	0.2881
Factor2	1.85023	0.03935	0.2657	0.5537
Factor3	1.81088	0.41720	0.2600	0.8137
Factor4	1.39368	1.33027	0.2001	1.0138
Factor5	0.06341	.	0.0091	1.0229

LR test: independent vs. saturated: chi2(28) = 211.42 Prob>chi2 = 0.0000

Rotated factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Uniqueness
nom_eer_2005	0.9478	-0.1744	-0.0525	-0.1404	0.0281	0.0481
real_ee~2005	0.8674	0.3882	0.2130	0.1285	-0.0004	0.0351
exports~2005	-0.0220	0.2431	0.8822	0.1351	-0.0404	0.1422
ir_bond~2005	0.3191	-0.3029	-0.2153	-0.7424	0.0617	0.2051
labourc~2005	0.1609	0.7811	0.2180	0.3974	0.1548	0.1346
relativ~2005	0.2115	0.2833	0.6625	0.6002	0.1220	0.0609
pricele~2005	0.4252	0.4183	0.5631	0.4936	0.0455	0.0813
inflati~2005	0.0452	-0.8080	-0.3666	-0.1620	0.1275	0.1682

Factor rotation matrix

	Factor1	Factor2	Factor3	Factor4	Factor5
Factor1	0.2544	0.5921	0.5872	0.4890	0.0285
Factor2	0.9571	-0.1290	-0.0877	-0.2393	0.0490
Factor3	-0.0229	-0.7152	0.6974	0.0399	0.0065
Factor4	-0.1161	0.3451	0.3989	-0.8277	-0.1522
Factor5	-0.0727	0.0473	0.0443	-0.1302	0.9867

Factor analysis/correlation — Number of obs = 239
Method: principal factors — Retained factors = 7
Rotation: (unrotated) — Number of params = 63

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor1	3.88245	1.23561	0.4451	0.4451
Factor2	2.64684	1.31847	0.3035	0.7486
Factor3	1.32836	0.55274	0.1523	0.9009
Factor4	0.77563	0.45326	0.0889	0.9898
Factor5	0.32236	0.20811	0.0370	1.0268
Factor6	0.11425	0.07678	0.0131	1.0399
Factor7	0.03747	0.05477	0.0043	1.0442
Factor8	-0.01730	0.02623	-0.0020	1.0422
Factor9	-0.04353	0.01708	-0.0050	1.0372
Factor10	-0.06062	0.03480	-0.0069	1.0303
Factor11	-0.09541	0.07307	-0.0109	1.0193
Factor12	-0.16848	.	-0.0193	1.0000

LR test: independent vs. saturated: chi2(66) = 2492.00 Prob>chi2 = 0.0000

Factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7	Uniqueness
per_hit~2015	0.4162	0.0706	0.2062	0.5960	0.1608	0.0705	0.0357	0.3919
per_kis_2015	0.8869	-0.0203	-0.0738	0.2847	-0.1974	-0.0016	-0.0038	0.0875
per_man~2015	-0.5880	0.3201	0.3286	-0.1728	0.2890	0.0949	-0.0506	0.3189
gfcf_2015	0.3057	0.2185	-0.0131	0.3253	0.2428	-0.0280	-0.0710	0.6880
nom_eer_2015	0.4935	-0.7872	0.2317	-0.1410	0.1450	-0.0748	0.0192	0.0362
real_ee~2015	0.5355	-0.6788	0.3837	-0.1657	0.0837	0.0740	0.0404	0.0637
exports~2014	-0.1274	0.6927	0.0837	-0.0260	0.1250	-0.0647	0.1473	0.4547
ir_bond~2015	-0.4512	-0.5865	-0.5189	0.1041	0.0844	0.0757	0.0666	0.1551
labourc~2015	-0.2935	-0.0283	0.7912	0.0988	-0.1569	-0.0926	0.0083	0.2440
relativ~2015	0.7107	0.5662	-0.1767	-0.1888	0.0682	-0.1258	0.0001	0.0869
pricele~2015	0.9282	0.0021	-0.1032	-0.2672	0.1283	-0.0014	-0.0092	0.0398
inflati~2015	0.5296	0.5154	0.1646	-0.1672	-0.1364	0.2326	0.0172	0.3259

Factor analysis/correlation — Number of obs = 239
Method: principal factors — Retained factors = 7
Rotation: orthogonal varimax (Kaiser off) — Number of params = 63

Factor	Variance	Difference	Proportion	Cumulative
Factor1	2.94494	0.36732	0.3376	0.3376
Factor2	2.57762	1.32523	0.2955	0.6332
Factor3	1.25239	0.00760	0.1436	0.7768
Factor4	1.24480	0.34167	0.1427	0.9195
Factor5	0.90312	0.76781	0.1035	1.0230
Factor6	0.13531	0.08613	0.0155	1.0385
Factor7	0.04918	.	0.0056	1.0442

LR test: independent vs. saturated: chi2(66) = 2492.00 Prob>chi2 = 0.0000

Rotated factor loadings (pattern matrix) and unique variances

Variable	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7	Uniqueness
per_hit~2015	0.1581	0.0997	0.1088	0.2232	0.7144	0.0269	0.0180	0.3919
per_kis_2015	0.4778	0.3019	-0.1371	0.6702	0.3491	0.0444	-0.0365	0.0875
per_man~2015	-0.0809	-0.3128	0.2757	-0.7049	-0.0492	0.0300	-0.0200	0.3189
gfcf_2015	0.2353	-0.0564	-0.1034	0.0618	0.4733	-0.1140	-0.0438	0.6880
nom_eer_2015	-0.0549	0.9656	-0.0272	0.1400	0.0261	-0.0862	0.0063	0.0362
real_ee~2015	0.0699	0.9495	0.0959	0.1026	0.0477	0.0888	-0.0031	0.0637
exports~2014	0.3634	-0.5228	0.1041	-0.2809	0.0869	-0.0465	0.2012	0.4547
ir_bond~2015	-0.8061	0.0576	-0.4155	0.0300	-0.1306	0.0032	0.0338	0.1551
labourc~2015	-0.1023	0.0784	0.8358	-0.1979	0.0387	0.0085	0.0086	0.2440
relativ~2015	0.8709	-0.0903	-0.3051	0.1691	0.0811	-0.1227	0.0560	0.0869
pricele~2015	0.7073	0.4962	-0.3844	0.2450	0.0735	-0.0210	0.0002	0.0398
inflati~2015	0.7554	-0.0672	0.0464	0.0860	0.0583	0.2927	-0.0184	0.3259

Factor rotation matrix

	Factor1	Factor2	Factor3	Factor4	Factor5	Factor6	Factor7
Factor1	0.6806	0.4738	-0.2195	0.4426	0.2607	0.0137	-0.0098
Factor2	0.6174	-0.7552	0.0661	-0.1722	0.1095	0.0152	0.0471
Factor3	0.1859	0.3209	0.8596	-0.3017	0.1633	0.0760	-0.0046
Factor4	-0.3432	-0.2440	0.1569	0.3973	0.7986	-0.0438	-0.0248
Factor5	0.0105	0.2041	-0.3923	-0.7026	0.4814	-0.2679	0.0849
Factor6	-0.0392	0.0211	-0.1730	-0.1726	0.1546	0.9355	-0.1979
Factor7	-0.0397	0.0231	0.0017	0.0476	0.0079	0.2119	0.9750

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